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## ADVERTISEMENT

The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, is intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects. The dates at which these separate papers are published are recorded in the table of contents of each of the volumes.

The present volume is the sixty-seventh of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogues of type-specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

ALEXANDER WETMORE,
*Assistant Secretary, Smithsonian Institution.*

WASHINGTON, D. C., *May 26, 1926.*

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[1] Date of publication.

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New species: *Microbracon punctatus, M. sphenophori, M. pyralidiphagus, M. rudbeckiae, M. tenuiceps, M. tychii, M. pini, M. sesiae, M. thurberiphagae, M. pityophthori, M. laemosacci, M. oenotherae, M. tachypteri, M. geraei, M. cerambycidiphagus.*

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By Benjamin Schwartz

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A. L. Treadwell

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# REVISION OF THE AMERICAN BUGS OF THE REDUVIID SUBFAMILY PLOIARIINAE.

By W. L. McAtee and J. R. Malloch.

*Of the United States Biological Survey.*

## INTRODUCTION.

Begun in an effort to get additional light on certain problems not solved by then-existing literature, this study has gradually grown to the proportions indicated by the title. That we have been able to go so far is due in large part to generous loans of material for which we record our great appreciation. The initial basis of the work was the very good collection of Ploiariinae in the United States National Museum, but we have been favored with loans of large numbers of specimens by the Academy of Natural Sciences of Philadelphia, through E. T. Cresson, jr.; the Carnegie Museum of Pittsburgh, through Dr. W. J. Holland; Cornell University, through Dr. J. C. Bradley; and the Museum National d'Histoire Naturelle de Paris, through Dr. E. L. Bouvier. Smaller, but none the less appreciated, lots of material have been received from the Universitetets Zoologiske Museum, Copenhagen, through William Lundbeck; the Riksmuseets Entomologiska Afdelning, Stockholm, through Dr. B. Y. Sjöstedt; the American Museum of Natural History, New York, through Dr. F. E. Lutz; the British Museum of Natural History, London, through C. J. Gahan; and the Bishop Museum, Honolulu, through O. H. Swezey. Dr. Walther Horn, of the Deutsches Entomologisches Institut, generously sent us, with other specimens, the type of *Phasmatocoris spectrum* Breddin. Individuals who have kindly loaned us valuable material are Dr. E. Bergroth, who sent us the types of all his American species; Nathan Banks, H. G. Barber, J. R. de la Torre Bueno, William T. Davis (including the type of *Ghilianella productilis* Barber), W. Downes, Dr. Carl J. Drake, J. S. Hine, Dr. H. S. Parshley, and Dr. Miles S. Pennington. Assistance in reporting on the characters of specimens in their care has been given by Nathan Banks, of the Museum of Comparative Zoology, Cambridge; W. E. China, of the British Museum; and C. W. Johnson, of the Boston Society of Natural History. The

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collections of the Boston Society, Museum of Comparative Zoology, and Field Museum of Natural History have been examined also by one of the authors during the progress of the work.

## THE GROUP TREATED.

(Subfamily Ploiariinae; Family Reduviidae.)

Insects of the subfamily Ploiariinae, in common with all other Reduviidae, have a longitudinal groove between the fore coxae which is invariably microscopically transversely striate, and in which the tip of the beak generally lies when at rest. This groove is called by some writers a "stridulatory groove" but whether it is really so we are unable to say. However, it is highly characteristic, as it is not present in any other family of Heteroptera known to us except the Phymatidae.

Absence of ocelli, and presence of anteriorly opening coxal cavities, and of usually very elongate fore coxae are the principal distinguishing characters of the Ploiariinae but neither is sufficient in itself for their recognition. The Saicinae also lack ocelli but the fore coxae are less elongate than in most Ploiariinae, the beak is armed with upwardly directed spines and the lower surface of the head is provided with two or more strong bristles. These spines and bristles are absent in the Ploiariinae. The Bactrodinae look considerably like Ploiariinae but differ structurally from them in characters more important even than do the Saicinae. The Bactrodinae have less elongate coxae than most Ploiariinae, possess ocelli, and the head is inserted not on the front or at most on the anterior margin of the prothorax but on the dorsum of that sclerite distinctly posterior to the front margin.

Expressing the most characteristic differences between these subfamilies in key form we have:

1. Anterior coxal cavities opening straight downward; ocelli none; underside of head with downwardly projecting, and beak with upwardly projecting, bristles or spines ........ **Saicinae.**
   Anterior coxal cavities opening forward and downward; head and beak without such armature ........ 2
2. Ocelli absent; head scarcely pedicillate, lower anterior border of prothorax scarcely produced beyond upper margin, on which the head is inserted. **Ploiariinae.**
   Ocelli present; head pedicillate; lower anterior border of prothorax produced distinctly beyond the upper margin, behind which the head is inserted. **Bactrodinae.**

The antennae in Ploiariinae are very long and slender, 4-segmented, sometimes with a pseudo-suture near apex of fourth segment which is often pointed and more or less angulate or curved; the beak is elongate, curved downward and backward, usually swollen at base, and acute at tip, and distinctly 3-segmented. The thorax is variously formed and the wings may be either large, reduced, or absent. The basal abdominal tergite is situated on the posterior part of thorax and the basal sternite is absent, a fact that should be borne in mind in counting the abdominal segments. The male hypopygium opens more or less dorsally, and the apical tergite sometimes entirely covers the orifice.

The fore wings of the Ploiariinae (as also those of some other Reduviidae) constitute an exception to a commonly accepted criterion to the Heteroptera, in that they are of uniform texture throughout. The venation has not been homologized with that of other insects and the names applied by us to the cells and veins are arbitrary terms, which however, are clearly defined in the explanation of plate 1.

The fore legs of Ploiariinae are adapted for capture of prey by closure hinge-wise of the fore tibia and tarsus against the lower surface of the fore femur. The opposing surfaces of the front femora and tibia are nearly always armed with spines or setulae, the arrangement of which is characteristic, as a rule, in each genus, minor variations in them indicating subgeneric or specific groups. The fore tibia has a rather conspicuous transverse slit (figs. 13, 18, 136, and 145) on the anterior surface near apex which is surrounded by dense pilosity. The fore tarsi present a range of differentiation not found in any group of similarly related forms known to us. In the case of this strictly predaceous subfamily, it is natural to suppose that evolution has been in the direction of efficiency in the most important raptorial organs, the front legs. In our opinion, the fore tarsus in its most generalized form consists of distinctly separated segments the terminal one with two equal claws. We assume the course of evolution to be from that condition through forms with poorly defined, heavily chitinized segments with one large and one small claw to a highly specialized stage in which the fore tarsus is thorn-like, the joints entirely fused, and wholly without differentiated claw. The mid and hind tarsi are invariably 3-segmented and being used in the normal manner, not for grasping prey, are not specialized.

## IS TRIBAL DIVISION OF THE PLOIARIINAE ADVISABLE?

Attempts have been made to define tribes of Ploiariinae, two of the principal efforts along this line being by Stal[1] and by Distant.[2] Put in the form of indented dichotomous keys these schemes are herewith appended.

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[1] Enum. Hemip., vol. 4, 1874, pp. 92–94.

[2] Fauna Brit. India, Rhynchota, vol. 2, 1904, pp. 201–216.

### TRIBES OF PLOIARIINAE ACCORDING TO STAL.

A[1]. Front femora armed for their whole length beneath with long, slender spines, all or most of them setiform; hind femora surpassing apex of abdomen; front tibia and tarsus together usually subequal in length to front femur, rarely distinctly shorter; body usually winged.

B[1]. Front tarsi short, segmented, flexible or sub-flexible, two-clawed, scarcely or not at all longer than hind tarsi; front tibia a little shorter than femur; hemelytra of species known to me marked with fuscous; scutellum and post-scutellum armed apically with spines.

**PLOIARIARIA.**
Ploiaria (=Empicoris).
Malacopus.
Stenolemus.

B[2]. Front tarsi long, scarcely or not at all shorter than tibia, one segmented or composed of three connate segments, subcurved, subcompressed, as seen from the side usually distinctly tapering toward apex, provided with two unequal contiguous or subcontiguous claws, or with one claw; front tibia much shorter than femur, sometimes only about half as long; first joint of antenna long; hemelytra scarcely or only very pale fuscous marked.

**LEISTARCHARIA.**
Orthunga.
Tinna.
Cerascopus.
Luteva.

A[2]. Front femur unarmed beneath toward the base or in front of middle; half or less than half its length, apically, armed with unequal spines; front tibia and tarsus together shorter than femur; body much elongated; head with the small eyes scarcely or only slightly wider than apex of thorax.

C[1]. Postocular part of head perceptibly tapering posteriorly, quite slender behind; hind femur distinctly, sometimes far, surpassing apex of abdomen; legs very long.

**EMESARIA.**
Gardena.
Ghilianella.
Emesa.
Ischnobaena.

C[2]. Postocular part of head scarcely or only slightly narrowed posteriorly, abruptly rotund coarctate at base; hind femur attaining or slightly surpassing apex of abdomen; head armed between the antennae with an usually very distinct tubercle or more often with a spine; tylus usually projecting as a spine.

**METAPTERARIA.**
Barce.
Metapterus.
Ischnonyctes.
Bargylia.

In criticism of the foregoing arrangement we would point out that:

1. The spines of the front femur of numerous species included under Stal's first major division are not setiform, but on the contrary, strongly chitinized.

2. Failure of the character of relative length of joints of front leg is admitted in the key.
3. "Usually winged" is an expression not applicable to *Cerascopus.*
4. Reference to color markings of hemelytra is entirely out of place in a key to tribes and especially when both sections are the same in this respect.
5. *Ploiaria* in the sense of *Ploiariola* (=*Empicoris*) is the inexplicable but frequent error of using the name of this monobasic genus for a species not the genotype nor congeneric with it.
6. There are no one-segmented tarsi in the genera named by Stal in his *Leistarcharia.*
7. *Orthunga* and *Tinna* are *Saicinae* not *Ploiariinae.*
8. *Cerascopus*=*Ploiaria* and we include *Luteva* as congeneric.
9. Head with eyes scarcely wider than apex of thorax is a character not in contrast with that of certain forms in the first division of key, species of *Ploiaria* for instance.
10. The attempt to define the tribes *Emesaria* and *Metapteraria* is futile; all gradations in posterior narrowing of head can be found in the species of the single genus *Ghilianella.* Most of the species of this genus have a spine or tubercle between antennae which would put the genus in the Metapteraria; and there is confessedly nothing to depend upon in length of hind femur.
11. *Barce*=*Metapterus.* Stal's character for separating them is of no more than specific importance.

TRIBES OF PLOIARIINAE ACCORDING TO DISTANT.

A.[1] Anterior femora spined beneath for their whole length.

B.[2] Anterior tarsi short, not longer, or a little longer than the posterior tarsi; hemelytra present or absent, when present, so far as known, ornamented with fuscous; scutellum and postscutellum frequently spined at apices.

**STENOLAEMARIA.**
**Stenolaemus.**
**Ploiariola.**
**Myiophanes.**
**Eugubinus.**

B.[2] Anterior tarsi long, not, or a very little shorter than the tibiae; hemelytra either not or sometimes very strongly marked with fuscous.

**LEISTARCHARIA.**
**Bagauda.**
**Luteva.**
**Ploearia.**

A.[2] Anterior femora spined beneath only from about or near middle.

C.[1] Head much narrowed at base; posterior femora either almost reaching or passing abdominal apex.

**EMESARIA.**
**Ghilianella.**
**Gomesius.**
**Ischnobaena.**
**Gardena.**

C.[2] Head not prominently narrowed posteriorly: posterior femora nearly reaching or passing abdominal apex; head between antenniferous tubercles distinctly spinous or tuberculous.

**METAPTERARIA.**
**Ischnonyctes.**

The criticisms of Stal's definitions of the tribes mostly apply to Distant's efforts also; and the lack of contrast in the characters assigned to the last two tribes is even more apparent. The truth is that the exact nature of important characters has been overlooked and an attempt made to define tribes upon criteria not acceptable even for the differentiation of genera. In our view attempting to recognize tribes of Ploiariinae is no more likely at the present moment to elucidate the relationships of the genera, than one would be led to suppose from the futile attempts of the past.

## CHARACTERS USED FOR THE RECOGNITION OF GENERA.

In arriving at decisions as to what groups constitute valid genera and subgenera we have used as our criteria characters that appear to us to be of phylogenetic value, and in our arrangement have indicated what are in our opinion evolutionary steps insofar as the available material has permitted.

We have used the wing venation to a greater extent than has previously been attempted in this group, and this character has proved very useful in the alignment of related forms. As noted above the structure of the fore legs and their armatures, and especially the segmentation and form of the fore tarsi, have been used to an even greater extent than in preceding works upon this subfamily, but these characters have invariably been correlated with venational and other structural characters in the final analysis before assigning any particular species to a genus or subgenus.

In our work on this and other groups we have endeavored to utilize as generic indices characters which appear to us to indicate a common origin for the included species, and slight departures from the general rule such as we find in *Ploiaria* and *Ghilianella*, we have not considered as sufficient grounds for elevating the divergent forms to full generic status. Had we failed to find the intermediate subgenus *Ploeodonyx*, linking *Ghilianella* s.s. and *Lissonyx* we would very probably have considered the latter as a valid genus but with an intermediate form present it is undesirable to give to these closely related segregates the same rank as we accord to such distinctly separated genera as *Gardena* and *Emesaya*.

In the case of the last two genera there is a striking similarity in wing venation accompanying a great dissimilarity in the structure of the fore legs, the tarsi of *Gardena* being of the generalized simple type, while those of *Emesaya* are heavily chitinized and subfused.

In this case the evidence of the venation of the wings, in our opinion, outweighs that of the fore tarsal structure as an index to relationship, and we consider the genera as much more closely related to each other than either is to *Stenolemus* or *Emesa.* That such a relationship should be expressed by the use of tribal designation may be urged, but it should not be forgotten that characters of generic value are distributed in many intermeshing combinations and that as a consequence, definition of tribes of phyletic significance becomes impracticable.

The characters used as generic criteria in this synopsis of the Ploiariinae may have in allied subfamilies and families either more or less significance, but in our work we have steadfastly adhered to the idea that when classifying these insects we were dealing with a group, which though related to others, is subject to modification through influences that may or may not have affected these related groups. Any group of organisms must be classified on the basis of the characters it possesses, and the value these or other characters have in other groups, has nothng to do with the case. Classified on the basis of venation practically all of the vast family of Anthomyiidae would fall into a single genus, on leg structure the Jassoidea could be but little divided, nor could Coccidae on the characters of the beak, and so on. A synopsis of a group should be based on characters inspection proves to be of value for that group. There has been no greater retarding factor in systematic entomology than that of grafting supplementary work here and there upon the old, of using the characters and methods that have been used instead of seeking something of greater significance. Each new piece of synoptic work should penetrate as much further into the heart of things as possible, judiciously noting and using, but neither copying nor worshipping previous contributions to the study.

Under each genus will be found a discussion of the characters and a systematic alignment of the included species, the groups being in all cases distinguished by means of characters that we consider are of more than specific value, but not of sufficient importance in most cases to justify the use of a distinctive appellation for the groups concerned.

## METHOD OF DESCRIPTION.

The keynote of descriptions throughout this paper is avoidance of repetition. In other words characters common to the whole subfamily are not mentioned in definitions of genera, and it has been our intention to hold to the minimum, repetition in specific descrptions of characters noted in descriptions of genera, in the keys to the species, or in descriptions of very similar forms. As a result, in some cases, specific descriptions may appear brief and inadequate. Nevertheless we believe the method adopted to be the best, not only because it saves space and therefore cost of printing, but what is more important it avoids burying in a mass of verbiage, the really essential points of characterization. Some entomologists insist upon the so-called full descriptions and while their motive is laudable, a little consideration of actual entomological practice indicates that the results are not those hoped for. It seems the almost certain fate, for instance, when revising a group, to find that no matter how "full" previous descriptions may be, they contain no mention of the particular detail about which information is sought. And this defect is inherent in the very nature of taxonomic practice. In every revision worthy of the name intensive search is made for new characters that will aid in classification of the group and the more success attained in finding them the more will previous descriptions fail to satisfy. Viewed from this standpoint, it is obvious that an isolated description, however lengthy, might fail to mention any character essential to recognition of the species. The moral is that the best method of describing new forms is in revisions where keys are given, and other comparisons made with related forms. A few words of description or comparison in such a connection is likely to be worth more than pages of description not formulated as a result of revisional work.

Statements of length in this paper refer to greatest length from front of head to tip of abdomen or of hemelytra as the case may be.

## PRINCIPAL WORKS CITED.

Because of the frequency with which certain writings on the Ploiariinae are cited, it seems desirable to adopt much abbreviated references to them. The shortened forms used and bibliographic references in full for the papers in point are given in the following lists:

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Original descriptions of 6 American species, and redescription of one of Dohrn's species.

CHAMPION. BIOLOGIA, 2. 1898.

CHAMPION, G. C. [Emesinae.] Biologia Centrali-Americana. Insecta. Rhynchota. Hemiptera-Heteroptera. vol. 2, pp. 162–175, pl. 10, figs. 7–24, October, 1898.

Key to the genera, two of which and 9 species are described as new.

DOHRN. EMESINA. 1860.

DOHRN, ANTON. Beiträge zur einer monographischen Bearbeitung der Familie der Emesina. Linnaea Entomologica, vol. 14, 1860, pp. 206–252, with Nachtrag, pp. 253–255, pl. 1.

Key to the genera, of which 3 that occur in the Americas, and 15 species are described as new.

DOHRN. NACHTRÄGE. 1863.

DOHRN, ANTON. Same title (Zweites Stück) and journal, vol. 15, 1863, pp. 42–63, with Nachträge, pp. 64–76.

Redescriptions of a number of genera and species both of Dohrn and other authors. In the Nachträge, two genera and 4 species from the Americas are described as new.

### KEY TO THE GENERA.

We have placed in the following key only those genera of which we have examined authentic material, including a few of extralimital distribution inserted for comparative purposes. Notes on other American genera follow the key.

1. Fore tarsi distinctly segmented, sometimes heavily chitinized and the segments subfused, but the dividing sutures always visible under a high-power lens; claws of fore tarsus consisting of an equal sized pair except in some species of **Ploiaria** and in **Deliastes** ........ 2

Fore tarsi without distinguishable segmentation under the highest power lens (even when cleared), consisting of but one heavily chitinized segment, with an unequal pair of claws, a single claw, or without distinct claws ........ 13

2. Fore femur without distinguishable ventral spines or bristles, only fine hairs present; third antennal segment as long as second and about three times as long as fourth; mesonotum without, metanotum with a spine; venation as in figure 1 ........ [3] **Emesopsis** Uhler (p. 13).

Fore femur with distinct spines or bristles on ventral surface which are readily distinguishable from any fine hairs which may be present except in some species of the genus *Empicoris;* third antennal segment not nearly as long as second and frequently shorter than fourth ........ 3

3. Ventral spines on fore femur commencing at or very close to base; fore tibia very distinctly over half as long as fore femur ........ 4

Ventral spines of fore femur commencing at or very close to middle; fore tibia not over half as long as fore femur ........ 12

4. Forewing with a closed subtriangular cell at basal extremity of the large discal cell, which does not touch margin of wing at any part (fig. 14); adults always winged; prothorax always with a deep constriction and distinctly bilobate, often pedunculate ........ 5

Forewing lacking a closed subtriangular cell at basal extremity of the large discal cell (fig. 11); adults sometimes apterous; prothorax neither pedunculate nor lobate, never more than slightly constricted ........ 8

5. A longitudinal vein which connects with either the small subtriangular cell or the base of discal cell fuses with the vein joining apex of former at some distance from base of wing so that the disk of wing has 3 closed cells

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[3] The Oriental species of this genus which we have seen have very weak spines on the ventral surface of fore femora and the antennae similar to those of *Empicoris* in general structure.

(figs. 45, 46, 47); mesonotum and metanotum sometimes with tubercles but without long spines at apices; fore tarsi 3-segmented.
**Emesa** Fabricius (**Westermannia** Dohrn) (p. 38).

When there is a vein connecting with the small discal cell it is usually short and its end is either free or it does not fuse with the other longitudinal vein, i. e., disk of wing with but 2 closed cells (figs. 33, 65, 66) ---------- 6

6. Mesonotum and metanotum without long spines; fore tarsi 3-segmented.
**Myiophanes** Reuter (Extralimital).

Mesonotum and metanotum each with a long spine or thorn---------- 7

7. Fore tarsi 3-segmented; no short vein emanating from costal margin of basal discal cell of forewing (fig. 65)----------**Polauchenia**, new genus (p. 47).

Fore tarsi 2-segmented; a short vein emitted from costal margin of basal discal cell (figs. 21, 23, 26, 29)----------**Stenolemus** Signoret (p. 25).

8. Fore tarsi 2-segmented, the segments nearly fused and subequal in length; claws unequal----------**Deliastes** Dohrn (p. 34).

Fore tarsi either 3-segmented or the segments not as above and claws equal ---------- 9

9. Pronotum not extending over mesonotum even in the winged forms; fore tarsus long, heavily chitinised, glossy and bare above, the 3 segments fused so closely that the oblique sutures are visible only under a very high-power lens; venation of forewings as in figures 73, 84, 89; adults often apterous----------**Ploriaria** Scopoli. (incl. **Luteva** Dohrn) (p. 48).

Pronotum extending over mesonotum to base of wings; adults always winged; fore tarsus short, not heavily chitinized nor glossy and bare above, the segmentation distinct---------- 10

10. Prothorax slightly constricted near anterior margin; mesonotum, metanotum, and basal abdominal tergite each with a long erect spine; fore tarsi 2-segmented.
**Empicoris** Wolff (=**Ploiariodes** Buchanan-White) (p. 13).

Prothorax slightly constricted at or near middle; mesonotum without a spine; fore tarsi 3-segmented---------- 11

11. Basal segment of beak shorter than second; fore tibia with a complete series of short ventral denticles; venation of forewing as in figure 43.
**Lutevopsis** Champion (p. 37).

Basal segment of beak longer than second; fore tibia with short decumbent pale setulae on ventral surface; venation of forewing as in figure 38.
**Panamia** Kirkaldy (p. 36).

12. Fore tibia almost half as long as fore femur; basal ventral spine of fore femur not longer than the longest of the others; fore tarsus with the segments well defined, not heavily chitinized, hairy above; venation of forewing as in figure 94; mesonotum highly glossy----**Gardena** Dohrn (p. 66).

Fore tibia not nearly half as long as fore femur; basal ventral spine of fore femur very distinctly longer than the longest of the others; fore tarsus with the segments poorly defined, heavily chitinized, bare above; venation of forewing as in figure 137; mesothorax sericeous.
**Emesaya** n.n. (for **Emesa** Authors not Fabricius) (p. 74).

13. Fore tarsus with two longitudinal series of angularly deflected spines which under a high power appear like elongate knife-like teeth on its ventral surface (fig. 166); head with a more or less pronounced spine or tubercle between bases of antennae, labrum closely adherent to base of rostrum, not projecting spine-like (fig. 165); adults never winged.
**Ghilianella** Spinola (p. 90).

Fore tarsus with two series of decumbent setulose hairs on its ventral surface (fig. 141); adults sometimes winged---------- 14

14. Head normally with two stout tubercles or spines, one between bases of antennae and the other (labrum) above base of proboscis (fig. 139); pronotum in winged form overlapping mesonotum to base of wings. **Metapterus** Costa (**Barce** Stal) (p. 83).

Head with neither of the above mentioned tubercles or spines (fig. 140); pronotum in winged forms not overlapping mesonotum except at anterior extremity ............ **Ischnonyctes** Stal (Extralimital[4]).

## NOTES ON AMERICAN GENERA NOT INCLUDED IN THE FOREGOING KEY.

*Emesella* DOHRN, Emesina. 1860, p. 239. [Monobasic, *E. nebulosa*, new species, genotype, Bolivia, pp. 239–240.] From the original description it is impossible to determine the relationships of this group. If *Emesella immitis* (Bergroth, Ploeariinen, 1906, pp. 312–314, Venezuela) really is congeneric, we should say from inspection of imperfect specimens of this species, that Emesella probably would place in our classification as a subgenus of *Ghilianella* near *Lissonyx*. Signoret adds a species to this genus, namely *E. dohrni* Revision des Hemipteres du Chili, Ann. Soc. Ent. France, ser. 4, vol. 3, 1863, pp. 587–588 [Chili].

*Malacopus* STAL, C. Bidrag till Rio Janeiro-Traktens Hemipter-Fauna, 1862, pp. 80–81. [Monobasic, *M. cellularis*, new species genotype, Brazil.]

*Palacus* DOHRN, Nachträge, 1863, pp. 74–75 [Monobasic *P. cubensis*, new species genotype, Cuba, p. 75.] See remarks under *Deliastes* p. 34. The species described by Guerin-Meneville as *Ploiaria pallida* is put in *Palacus* by Lethierry and Severin, Cat. Gen. Hemip., vol. 3, 1896, p. 74. The original description of the species occurs in Sagra, Ramon de la, Historia Fisica, Politica y Natural de la Isla de Cuba, vol. 7, Crustaceos, Aragnides e Insectos, 1856 [Cuba]. This name is preoccupied by *Ploiaria pallida* Montrouzier, P., Essai sur la Faune de l'Isle de Woodlark ou Moiou, Ann. Sci. Phys. Nat. Lyon, ser. 2, vol. 7, pt. 1, 1855, p. 110.

## SYSTEMATIC ARRANGEMENT OF THE AMERICAN GENERA

In connection with this arrangement we would first point out that in this as in most groups of existing insects there is little to which the much overworked word "primitive" can legitimately be applied. Rather we have in the modern insect world the products of specialization along a multitude of intercrossing lines, any one of which may be highly specialized in some, and but little specialized in other respects. The selection of the least specialized form and the tracing of the probable course of evolution in a group, is, therefore, a subject upon which opinion may vary greatly, according to the choice of characters of primary, secondary, and lesser degrees of importance.

Adhering to the idea that development of predatory efficiency is the course of evolution of the Ploiariinae we believe little objection can be made to placing *Emesopsis* at the base of the American series of genera. While the venation of this genus is more complex and therefore less specialized according to a prevalent view of the subject, there can be little doubt that this specialization is secondary, for there is no probability that an insect participating in the long course of evolution of so specialized a group as the Ploiariinae could carry along the whole route a primitive type of venation.

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[4] There is a damaged specimen of *Ischnonyctes* in the National Collection, labelled N. O., La., R. H. Browne. We assume this is an accidentally introduced individual, and that it was collected in New Orleans.

Theoretical considerations are involved also in the question as to whether the possession of 2-segmented fore-tarsi (a nymphal character) is a forward- or a backward-looking specialization. Despite the fact that it would appear to be a step toward greater predatory effectiveness we have been obliged to give greater weight to certain other characters when the whole organization of a genus having 3-segmented fore tarsi seemed to be more perfectly fitted for predation.

We have endeavored to strike a fair balance among the characters entitled to consideration in settling upon a systematic arrangement, and believe we have been in a better position for so doing than our predecessors because of the much larger amount of material examined.

- Fore tarsi segmented.
  - Fore femora without spines or bristles; fore tarsi 2-segmented; forewing reticulate toward base, with about 5–6 discal cells. **Emesopsis** (p. 13).
  - Fore femora with spines or bristles; forewing (when present) with fewer discal cells.
    - Fore femora spined for almost their whole length; fore tibiae relatively long.
      - Fore tarsi 2-segmented.
        - Fore tarsi not heavily chitinized, basal segment the shorter, claws equal; apices of meso- and meta-thoraces, each usually bearing a spine.
          - Forewing with one discal cell; prothorax scarcely constricted. **Empicoris** (p. 13).
          - Forewing with two discal cells; prothorax deeply constricted or pedicillate---------- **Stenolemus** (p. 25).
        - Fore tarsi heavily chitinized, segments subfused, subequal, claws unequaled; meso- and meta-thoraces without spines; forewing with 3 discal cells---------- **Deliastes** (p. 34).
      - Fore tarsi 3-segmented.
        - Fore tarsi usually flexible, hairy, at least above, claws equal.
          - Meso- and meta-notum each with a spine; fore wing with 2 discal cells---------- **Polauchenia** (p. 47).
          - Meso- and meta-nota unspined.
            - Fore wing with 3 discal cells---------- **Emesa** (p. 38).
            - Fore wing with 1 discal cell---------- **Panamia** (p. 36). **Lutevopsis** (p. 37).
        - Fore tarsi inflexible, polished, sutures inconspicuous, claws usually unequal; fore-wing when present with 1 discal cell. **Ploiaria** (p. 48).
    - Fore femora spined on distal half; fore tibiae relatively shorter; fore wing with 1 discal cell---------- **Gardena** (p. 66). **Emesaya** (p. 74).

Fore tarsi not segmented (even in nymphs); fore wing (when present) with 2 discal cells ........................................ **Metapterus** (p. 83).
**Ghilianella** (p. 90).

## SYSTEMATIC ACCOUNT OF THE GENERA AND SPECIES.

### Genus EMESOPSIS Uhler.

*Emesopsis* UHLER, P. R. A list of the Hemiptera-Heteroptera collected in the Island of St. Vincent by Mr. Herbert H. Smith; with descriptions of New Genera and Species. Proc. Zool. Soc. London, 1893, p. 718 [Monobasic, genotype *E. nubilus*, new species, St. Vincent: Cuba].

In addition to the characters in the key the following may be mentioned for this genus: Head and prothorax similar to those of Empicoris, the prothorax however, without lateral carinae. The mesonotum is produced into a backwardly directed subtriangular process which is rounded above, the metanotum has a long erect slender spine at apex, and the basal abdominal tergite has a much shorter spine. Fore tarsi as in *Stenolemus*: Basal segment of beak about twice as long as second, the latter subglobose; the third joint slender, nearly as long as first. The reticulate venation of corium is very characteristic (see fig. 1).

### EMESOPSIS NUBILUS Uhler.

*Emesopsis nubilus* UHLER, P. R. Proc. Zool. Soc. London, 1893, pp. 718–9 [St. Vincent: Cuba].

A testaceous yellow species without distinct markings, the fore wings with indistinct yellowish brown mottling; eyes ruby red. Posterior lobe of head convex, distance from posterior margin of eye to back of head about twice as great as from anterior margin of eye to front of head and greater than width of eye; hairs of antennae much shorter than those of mid and hind legs. Fore coxae a little over half as long as fore tibiae, the latter over four-fifths as long as femur. Abdomen elongate ovate, the lateral outline smooth, spiracles slightly elevated; spical margin of male hypopygium produced into a subtriangular plate, the apex of which is thorn-like; claspers long, slender, curved at apices; apex of abdomen of female without processes, similar to that of females of *Empicoris*. Venation of fore wing as in figure 1.

Length 4–5 mm.

*Localities.*—Mount Gay Estate, and Balthazar, Grenada, West Indies, H. H. Smith; Cayamas, Cuba, May 31, June 5, E. A. Schwarz; Cuba, Uhler Collection (U.S.N.M.).

### Genus EMPICORIS Wolff.

*Empicoris* WOLFF, J. F. Icones Cimicum Descriptionibus illustratae, Fasc. 5, 1811, p. IV [Monobasic, *Gerris vagabundus* Linnaeus genotype].

*Ploiariodes* WHITE, F. BUCHANAN. Descriptions of new species of Heteropterous Hemiptera collected in the Hawaiian Islands by the Rev. T. Blackburn.—

No. 3, Ann. and Mag. Nat. Hist., ser. 5, vol. 7, 1881, pp. 58–59. [Monobasic, *P. whitei* Blackburn ms., genotype, Mauna Loa.]

*Ploiariola* Reuter, P. M. Revisio synonymica Heteropterorum palearcticorum quae descripserunt Auctores vetustiores (Linnaeus 1758–Latreille 1806). II. Acta Soc. Sci. Fennicae, vol. 15, 1888, p. 711 [New name for *Ploiaria* of Latreille not of Scopoli, the genotype of which, *Cimex vagabundus* Linnaeus automatically assumed the same relation to the new name.]

Emendations: *Ploeariodes; Ploeariola.*

We are not in ignorance of what has been said[5] in favor of regarding *Ploiariodes and Ploiariola* as distinct genera, but we find the chief character advanced for their separation, namely the lateral carina of pronotum, showing practically all phases from distinct to obsolete.[6] Even were this character unequivocal we should regard it of no more than subgeneric value in view of the agreement throughout the species in general coloration and habitus as well as in the venation of the forewings and the structure of the fore legs. All species known to us have the legs and antennae as well as the beak with blackish spots or annuli, and the wings are invariably dark spotted. The head and thorax have silvery hairs, usually arranged in distinct lines, some of these being almost invariably evident on pleura and pectus. The pronotum is more or less distinctly vittate, at least behind the constriction but there are some differences in this respect which are used in defining a few of the species; the carina on side of pronotum is nearly always pale. The abdomen usually is dark, with the spiracles and spots on connexivum pale, the venter finely pubescent, with more or less of the median line, and sometimes spots about bases of certain longer hairs, bare.

The radial vein runs to beyond the middle of the fore wing, ending in the costa, the apical portion of it being what we have called the "stigma" which offers some good distinguishing characters for the species both in its shape and color. The pronotum is divided into two parts by a broad constriction, the anterior part being about half as long as the posterior, but there are no species known to us in which the pronotum is at all pedicillate. All species have the mesonotum and metanotum, and usually the basal abdominal tergite with a slender thorn on the middle of the hind margin; the presence or absence of a process on middle of hind margin of the pronotum is a specific character. The spines or bristles on fore femora are sometimes difficult to see even with a high power lens.

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[5] Especially Bergroth, E. Ploeariodes B. White und Ploeariola Reut. (Hemiptera-Heteroptera, Reduviidae.) Rev. Russe d'Ent., vol. 9, No. 3, Nov. 1909, p. 324.

[6] We have examined several species from the Oceanic region in addition to those treated herein.

KEY TO THE SPECIES.

1. Pronotum with the lateral carinae distinguishable only at anterior and posterior extremities, obsolete in middle; eighth sternite in male with a large rounded central incision in posterior margin (fig. 2); stigma with a reddish line along inner or posterior margin from cross-vein to apex. **rubromaculatus** (Blackburn) (p. 16).

   Pronotum with the lateral carinae complete, pale colored on their entire length; eighth sternite in male produced in middle of hind margin; stigma without a red line along inner margin apically.................... 2

2. Pronotum with two dorsal linear yellowish carinae similar to the lateral carinae, extending the entire length of dorsum; dark markings of forewings peppered with minute hyaline dots; lateral carinae of pronotum not capitate at anterior extremity........**barberi** (McAtee and Malloch) (p. 19).

   Pronotum without sharp dorsal carinae, with two slight rounded longitudinal elevations; dark markings of forewings solid; lateral carinae more or less distinctly produced or capitate at anterior extremities................ 3

3. Hind wings conspicuously spotted with black apically, or fuscous with white reticulations.................................................... 4

   Hind wings not spotted apically or very faintly so at extreme tip (cf. *orthoneuron*).................................................... 5

4. Pronotum with a conspicuous tubercle on middle of hind margin; anterior extremity of lateral carina of pronotum with a small capitate process which projects nearly at right angles to pronotum; fore wings not perceptibly honeycombed as in next species; vein closing posterior half of apex of discal cell much more conspicuously bent than its fellow (fig. 11). **errabundus** (Say) (p. 24).

   Pronotum without a median tubercle on hind margin; lateral carina of pronotum with at most a slight process at anterior extremity which is not capitate nor at right angles to pronotum; fore wings microscopically honeycombed with fine black lines which are most noticeable basad of apex of discal cell and in the dark spots of membrane (best seen in transmitted light); veins closing discal cell almost symmetrically formed. **reticulatus**, new species (p. 20).

5. Both veins closing discal cell of hemelytra at apex nearly straight (fig. 4); posterior lobe of pronotum not narrowed in front, a little broader than long, without a median process on middle of hind margin, the lateral carina with a small process at anterior extremity; wing without microscopic honeycombing; hind wings may be faintly spotted apically. **orthoneuron**, new species (p. 18).

   At least the vein closing posterior half of apex of discal cell conspicuously bent or angulated; posterior lobe of pronotum as long as or longer than broad, narrowed anteriorly, the sides not straight; wings without microscopic honeycombing ............................................ 6

6. The large fuscous spots on forewings irrorated with minute clear dots; one or two of the spines at base of ventral series on fore femur about as long as the femoral diameter and quite stout; fore coxa stouter than usual, not longer than distance from coxal cavity to upper margin of pronotum; tubercle on hind margin of pronotum small, the lateral carina with a small process at anterior extremity which projects at nearly right angles to the pronotum.................................**parshleyi** (Bergroth) (p. 22).

   The large fuscous spots on forewings not irrorated; fore femoral spines not nearly as long as the femoral diameter; fore coxa longer than distance from coxal cavity to upper margin of pronotum anteriorly.... 7

7. Pronotum with a distinguishable tubercle on middle of hind margin---- 8
Pronotum without a distinguishable tubercle on middle of hind margin- 10

8. Tubercle on middle of hind margin of pronotum very small, the linear white vittae distinct in front of constriction, almost straight, disk almost bare; bases of fore wings spotted with fuscous.
**subparallelus**, new species (p. 21).
Tubercle on middle of hind margin of pronotum large--------------- 9

9. Pronotum with two conspicuously curved linear pilose white vittae which are distinct in front of constriction; bases of fore wings white.
**nudus**, new species (p. 22).
Pronotum with two moderately broad whitish vittae which do not extend in front of constriction nor to hind margin, the disk with rather conspicuous white decumbent hairs; eighth sternite in male with a very slender apical process (fig. 8)-------------**armatus** (Champion) (p. 20).

10. Stigma linear, entirely black, forming a conspicuous costal streak centered on vein closing costal half of discal cell, the latter much longer than that closing the other half (fig. 6); cross-veins in middle of hind wing forming a straight line (fig. 7)-----------------**winnemana**, new species (p. 19).
Stigma widened beyond vein closing costal half of discal cell, the latter not longer than that closing other half (fig. 3); cross-veins in middle of hind wing forming an angulate line------------------------------- 11

11. Stigma with two or three blackish spots beyond the cross-vein; male hypopygial claspers knobbed, the knob concave at tip (fig. 9).
**culiciformis** (DeGeer) (p. 23).
Stigma without dark spots beyond the cross-vein; claspers not knobbed.
**vagabundus** (Linnaeus) (p. 17).

## SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Lateral carinae of pronotum incomplete; armature of fore femora consisting of uniform bristly hairs, none as long as femoral diameter; pronotum without tubercle on hind margin----------------------------------**rubromaculatus.**

Lateral carinae of pronotum complete.

Armature of fore femora consisting chiefly of bristly hairs, often with spine-like bases.

Pronotum without a tubercle on hind margin----------**vagabundus.**
**orthoneuron.**
**barberi.**
**winnemana.**
**reticulatus.**

Prontum with a tubercle on hind margin----------- **armatus.**
**subparallelus.**
**nudus.**

Armature of fore femora more definitely spinous, usually a few spines at base of series are longer than the others.

Pronotum without a tubercle on hind margin. **parshleyi.**
**culiciformis.**

Pronotum with a tubercle on hind margin.
**errabundus.**

### EMPICORIS RUBROMACULATUS (Blackburn).

*Ploiariodes rubromaculata* BLACKBURN, T. Notes on the Hemiptera of the Hawaiian Islands, Proc. Linn. Soc. New South Wales, ser. 2, vol. 3, 1889, p. 349 [Mauna Loa, Hawaii].

*Ploiariodes euryale* KIRKALDY, G. W. A Catalogue of the Hemiptera of Fiji, Proc. Linn. Soc. N. S. W., vol. 33, 1908, p. 372 [Riwa, Fiji].

*Ploïariodes californica* BANKS, N. Emesidae, 1909, p. 46 [Stanford University, Calif.].

*Ploiariola froggatti* HORVATH, G. Miscellanea hemipterologica XV, Ann. Mus. Nac. Hung., vol. 12, 1914, pp. 643–644, fig. 5 [Sydney, New South Wales].

This species is readily distinguished by the characters cited in the key. In some cases the anterior rudiment of the lateral carina is dark in color and therefore inconspicuous. The fore femur is about as long as the pronotum and the apical antennal segment is not over one-third as long as the third segment. This species has no round bare spots at bases of the longer hairs on venter as in *errabundus* and some others. For the male genitalia, see figure 2.

Length: 5–5.5 mm.

*Specimens examined.*—Kilauea, Hawaii, 4,000 feet. (Bishop Mus., det. Kirkaldy); Haleakala, Maui, Hawaii, 5,000 feet, R. C. Perkins (British Mus.); Mount View, Calif., G. W. Ehrhorn; Alameda County, Calif., December (U.S.N.M.); Salinas, Calif., June 20, 1908, Riverside, Calif., June 10, 1908, E. D. Ball (Ball); Stanford University, Calif., September (Holotype of *Ploiariodes californica* Banks, Mus. Comp. Zool.); Palo Alto, Calif., Sept., 1908, Bradley (Van Duzee); Berkeley, Calif., Oct. 31, J. C. Bradley (Cornell Univ.); Calcedonia, Miss., June 24, 25, 1921, C. J. Drake; Gainesville, Fla., J. R. Watson (Drake); Chain Bridge, Va., Sept. 11, 1921, J. R. Malloch. (Biol. Survey); Rio Piedras, Porto Rico, July 23, 1916, E. G. Smyth (U.S.N.M.); Tallabao near Ponce, Porto Rico, July 23, 1914 (Am. Mus.); Rio de Janeiro, Brazil (Carnegie Mus.).

A male collected at Funchal, Madeira, December 30, by F. Jones (U.S.N.M.) differs only in having no red streak along inner margin of the stigma. Since this marking varies in extent and intensity in the other specimens studied we are not inclined to consider this form as a distinct species.

### EMPICORIS VAGABUNDUS (Linnaeus).

*Cimex vagabundus* LINNAEUS, C. Systema Naturae per Regna tria Naturae, secundum Ordines, Genera, Species cum characteribus, differentiis, synonymis, locis., ed. 10, 1758, p. 450 (Engelmann Reprint 1894) [Europe].

We have examined several European specimens of this species which agree in all particulars with those from North America. The armature of fore femora, the lack of pronotal tubercle, and the shape and color of the stigma are characteristic; the apical antennal segment is not more than one-third as long as preapical. Apex of forewing as in figure 3.

Length; 6–7 mm.

### KEY TO THE VARIETIES.

*A.* Antennae and fore femora with very short hairs, those on the former very little longer than the segmental diameter; general color usually somewhat fuscous ---------------------------------------------- vagabundus.

*AA.* Antennae and fore femora with very long hairs, those on the former about four times as long as the diameter of segments; general color usually whitish ---------------------------------------------- pilosus.

### EMPICORIS VAGABUNDUS, var. VAGABUNDUS (Linnaeus).

Original citation same as for the species.

*Ploiariola canadensis* PARSHLEY, H. M. On some Hemiptera from Western Canada. Occasional papers of the Museum of Zoology, University of Michigan, No. 71, Aug. 29, 1919, pp. 25–27 [Victoria, B. C.].

American specimens examined are from Victoria, B. C., August 18, 25, 1919, W. Downes, including type of *P. canadensis* Parshley (Downes, Parshley.); Washington, D. C., from the breeding cage of the Division of Entomology, June 10, 1898, F. H. Chittenden (Cornell Univ.). The scutellar spine is not developed in Parshley's type and in certain other specimens, but this is a malformation.

### EMPICORIS VAGABUNDUS, var. PILOSUS (Fieber).

*Ploearia pilosa* FIEBER, F. X. Die europäischen Hemiptera. Halbflügler (Rhynchota Heteroptera), 1861, pp. 149–150 [France].

*Ploiariodes hirtipes* BANKS, N. A new species of Emesidae from Vermont. Psyche, vol. 19, No. 3, June 1912, p. 97 [Brattleboro, Vt.].

This variety is represented in North American material by specimens which agree exactly with a European example.

Full data for the specimens examined are: Wisconsin; Pennsylvania no other data (U.S.N.M.); Nantucket, Mass., Aug. 21, 1911 (Parshley); Victoria, B. C., Aug. 16, 18, 1919, W. Downes (Downes); Brattleboro, Vt., July 15, 1908, C. W. Johnson, type of *P. hirtipes* Banks (Bost. Soc. Nat. Hist.).

This form has been recorded also from Gogebic County, Mich. (Hussey, R. F., Pysche, 28, No. 1, Feb. 1921, p. 10).

### EMPICORIS ORTHONEURON, new species.

*Male.*—Similar to *errabundus* in color, except that the type shows no distinct spotting at the apices of the hind wings, but these wings in this specimen are in poor condition and it is not possible to be absolutely sure of this character. The venation of apex of the discal cell is as in *reticulatus*, but the minute honeycomb of lines is absent (fig. 4), the stigma is narrower, fuscous, and there is a more conspicuous blackish mark on middle of veins closing discal cell and the base of the vein that emanates from them. The form of the apical sternite is shown in figure 5.

Length, 4 mm.

*Holotype.*—Monterey, Calif., July 12. E. A. Schwarz (U.S.N.M.).

A female from Santa Cruz, Calif., August (Coll. Parshley) also is in poor condition, the wings being stuck to abdomen, but apparently the hind pair are faintly spotted apically.

*Type.*—Cat. No. 27090 U.S.N.M.

### EMPICORIS BARBERI (McAtee and Malloch).

*Ploiariodes barberi* McATEE, W. L., and MALLOCH, J. R. American Museum Novitates, No. 75, May 11, 1923, pp. 7–8 [Porto Rico].

*Male.*—Head with white pruinosity in front of eyes and a white line from base of each antenna, which connects with another that runs diagonally from lower hind margin of eye to upper occiput; faint lines of pruinosity on lower sides of pronotum in front and on pleura, and posterior and lateral margins, and lateral and dorsal carinae of pronotum white. Abdominal spiracles white; venter mottled, each sternite with a large round bare spot on each side on hind margin. Antennae and legs with narrow annulations, a subapical one on each femur and on first segment of antenna broader. Dark areas on fore wings profusely areolate with minute pale dots; apices of hind wings fuscous with white reticulations.

Pronotum without median tubercle on hind margin; submedian dorsal carinae as sharp as the lateral ones, but little curved; mesonotal and metanotal thorns absent in type, the one at base of abdomen distinct. Apical abdominal sternite not deeply excavated at tip. Fore femur with very weak ventral spinules. Stigma normal, cross-vein closing apex of discal cell on its anterior half straight, the other one curved.

Length (without wings): 3 mm.

*Holotype.*—Tallabao, near Ponce, Porto Rico, July 23, 1914, H. G. Barber (American Museum).

Named in honor of the collector. This is one of the most distinct species known to us. The submedian dorsal pronotal carinae are not sharp in any other species, and the only other which has the dark areas of the forewings with minute hyaline dots is *P. parshleyi* Bergroth.

### EMPICORIS WINNEMANA, new species.

*Male.*—This species differs from all the others in having the legs and antennae almost entirely brownish fuscous, with but faint annuli except at extreme apices of segments, the fore and mid femora alone showing distinguishable annuli. The pronotum is almost uniformly brownish and the thoracic spines are stramineous. The wings are as in *errabundus*, but the linear stigma is entirely black as far before as beyond the cross-vein.

Antenna with short pubescence, apical segment over one-third as long as the subapical. Lateral carina of pronotum not sharp. Apical abdominal sternite subtriangular, hypopygial claspers slender, tapered at apices. Fore femur over twice as long as coxa, rather densely short haired ventrally, the spines minute. Stigma and veins closing discal cell as in figure 6. Cross-veins in middle of hind wing forming a straight line (fig. 7).

*Female.*—Similar to male, the abdomen broader.

Length, 4.5 mm.

*Holotype.*—Plummer Island, Md., October 10, 1921, taken at light in the cabin of the Washington Biologists' Field Club, H. L. Viereck (U.S.N.M.), Allotype, Vienna, Va., October 17, 1890, (Cornell Univ.).

*Type.*—Male, Cat. No. 26703, U.S.N.M.

### EMPICORIS RETICULATUS, new species.

*Male and female.*—Similar to *errabundus* in color, the spots at apices of hind wings very distinct. Differs as indicated in key, the reticulation or honeycombing of forewings visible only under a very high power. The apical abdominal sternite of male is similar to that of *orthoneuron* and quite different from that of *errabundus* (figs. 5 and 12). As in *errabundus* and *orthoneuron* the cross-veins in middle of hind-wings are angulated and the apices of forewings are notched where the vein joins the margin. Apical antennal segment nearly half as long as preapical. Base of abdomen with a much shorter dorsal thorn than in *errabundus.*

Length, 5–6 mm.

*Holotype.*—Male, Cordoba, Mexico, December 25, 1907, F. Knab, Allotype, found on imported orchids from Port Barrios, Guatemala; Paratype male, Natchez, Miss., June 2, 1909, E. A. Schwarz (U.S.N.M.); female, Plummer Island, Md., August, 1903, A. Busck (Cornell Univ.); Plummer Island, Md., Sept. 9, Falls Church, Va., Oct. 13, N. Banks; Malden, Mass., Oct., 1883, F. H. Sprague (Mus. Comp. Zool.).

*Type, allotype, and paratype.*—Cat. No. 26704, U.S.N.M.

### EMPICORIS ARMATUS (Champion).

*Ploiariodes armata* CHAMPION, G. C. Biologia, vol. 2, 1898, p. 165 [Guatemala; Panama].

*Ploeariola mansueta* BERGROTH, E. The American Species of Ploeariola Reut. (Hem. Reduviidae). Notulae Entomologicae, vol. 2, 1922, pp. 51, 80–81 [Sanford, Fla., Mandeville, Jamaica].

Head with white decumbent hairs which form three curved longitudinal lines on each side, one from lower posterior angle of eye, one from just above middle of eye and a third from upper posterior angle of eye, the latter curved inward at middle. Pronotum with two whitish submedian vittae which do not reach anterior or posterior margins, the space betwen them yellowish, laterad of these and across their posterior extremities dark brown, hind margin of pronotum narrowly pale yellowish in middle, broadly so on each posterior laterial angle, dorsum with rather dense decumbent white hairs; mesonotal spine dark brown, pale at tip; mentanotal spine whitish; basal abdominal spine dark brown. Abdomen brown, venter unspotted, spiracles and a connexival streak in front of them on each segment, whitish. Wing spots not irrorate; stigma from cross-vein to near tip filled with two contiguous or subcontiguous brown or fuscous spots.

Lateral pronotal carina complete, without anterior process; median process on hind margin of pronotum stout, conspicuous. Fore coxa slender, almost as long as pronotum and half as long as femur. Vein closing posterior half of discal cell much curved. Apical antennal segment fully one-third as long as preapical. Male genitalia as in figure 8.

Length, 4–5.5 mm.

*Localities.*—Sanford, Fla., April 26, 1908, Mandeville, Jamaica, April 1906, E. P. Van Duzee (Type material *Ploeariola mansueta* Bergroth, Coll. Van Duzee); Aibonito, Porto Rico, July 14–17, 1914 (Am. Mus.); Paraiso, Canal Zone, February 10, 1911 E. A. Schwarz; Cacao Trece Aguas, Guatemala, April 21, E. A. Schwarz and H. S. Barber; Vega Alta, Porto Rico, February 26, 1917, R. J. Cotton, Paradise Key, Fla., Feb. 28, 1918, E. A. Schwarz (U.S.N.M.); Sebastian, Fla., February 11, 1919, A. Wetmore (Biol. Survey); Gainesville, Fla., June 9, 1918, C. J. Drake (Drake.).

We had this species identified as *armatus* Champion prior to the appearance of Doctor Bergroth's paper and to settle whether we were in error we requested W. E. China to supply data from an examination of the type. The information kindly furnished by that gentleman confirms our identification and synonymy.

### EMPICORIS SUBPARALLELUS, new species.

*Male.*—Similar to *nudus* in color and structure, differing as stated in key. The black spots on antennae are much smaller than in *nudus*, and especially apically, the last two segments in *nudus* being almost entirely fuscous whereas in *subparallelus* they are largely white, the apical segment having a small black spot at base and a larger one near apex.

Length, 4.5 mm.

*Type.*—Cayamas, Cuba, March 2, E. A. Schwarz (U.S.N.M.).

A female specimen from Brownville, Texas, May 7, H. S. Barber, (U.S.N.M.), lacking the head and most of the legs appears to belong to this species; the pronotal tubercle is better developed than in the type.

*Type.*—Male, Cat. No. 26705, U.S.N.M.

### EMPICORIS NUDUS, new species.

*Female.*—Head marked as in *armatus;* the white lines are not composed of moderately long decumbent hairs but of microscopic pile or pruinescence, and the two lines on dorsum are regularly arcuate, the anterior and posterior extremities being incurved. The dorsum of pronotum is chocolate brown on disk between the white lines, the latter are very slender, converge from anterior margin to constriction, and then arcuately diverge, ending a short distance from hind margin of pronotum; laterad of the white lines the posterior half of pronotum is paler brown; there is a slender white Y-shaped mark extending from constriction over humerus on each side, a white line along the hind margin, and the lateral carinae are white. In other respects as *armatus.*

Pronotum almost nude, processes and spines as in *armatus.* Fore coxa stouter than in that species, distinctly shorter than pronotum, and half as long as femur; stigmatal spot farther from apex. Apical antennal segment fully half as long as preapical.

Length, 4.5 mm.

*Holotype.*—Paradise Key, Fla., March 6, 1919, E. A. Schwarz and H. S. Barber (U.S.N.M.).

### EMPICORIS PARSHLEYI (Bergroth).

*Ploeariola parshleyi* BERGROTH, E. Am. Ploeariola. Notulae Entomologicae, vol. 2, 1922, pp. 50–51 and 79 [Falls Church, Va.].

Color decidedly more brownish than in *errabundus.* Dorsum of pronotum behind suture pale yellowish brown, but little darker than the lateral carinae; thoracic spines pale. Venter of abdomen pale brown, unspotted. Most of the fuscous spots on wings and especially those in discal cell with minute clear dots in them; apices of hind wings not spotted. Legs and antennae ringed and spotted with fuscous.

Pronotum with lateral carina, which has a small process at anterior extremity, and with a poorly developed but distinguishable median process on hind margin. Fore legs short and stout, the femur not longer than the pronotum, the coxa about half as long as the femur and not longer than distance from coxal cavity to upper anterior margin of pronotum. Stigma normal, rather broadly rounded at apex; discal cell produced at apex, both veins closing cell curved. Apical antennal segment fully half as long as preapical.

Length, 5–6 mm.

*Localities.*—Falls Church, Va., August 1, N. Banks (Holotype, Coll. Bergroth); same locality, August 22 (Amer. Mus. Nat. Hist.) same locality, August 6, 25, N. Banks (Mus. Comp. Zool.); Plummer Island, Md., June 27, 1911, August 10, 1915, H. S. Barber (U.S. N.M.); Contoocook, N. H., July 16, 1920, E. W. Hall (Drake); Beverly, Mass., July 15, 1906 (Bost. Soc. Nat. Hist.).

### EMPICORIS CULICIFORMIS (De Geer).

*Cimex culiciformis* DE GEER, CHARLES. Mem. Hist. Insects, 3, 1773, pp. 323–8, pl. 17, figs. 1–8 [France].

*Ploiaria alata* SCOPOLI, J. A. Deliciae Florae et Faunae Insubricae, etc., pt. 3, 1788, pp. 52–53, pl. 25, figs. 6–10 [Austria].

*Gerris erraticus* FALLEN, C. F. Monographia Cimicum Sueciae, 1818, pp. 117–118.

*Ploiaria maculata* HALDEMAN, S. S. Descriptions of several new species and one new genus of insects. Proc. Acad. Nat. Sci. Phila., vol. 3 (1846–7) 1848, p. 151 [Pennsylvania]. A longer description is given in a later article by Haldeman entitled "On four new species of Hemiptera of the genera Ploiaria, Chermes, and Aleurodes," etc. (Amer. Journ. Sci., ser. 2, vol. 9, 1850, p. 108).

*Ploiariodes errabunda* BANKS, N. Emesidae, 1909, p. 46 [Va., Md.].

We have before us several European specimens of this species including one male. A number of North American specimens, comprising males also, agree in every particular with those from Europe so that we have been compelled to accept the American species as *culiciformis*. In color it agrees very closely with *errabundus* but it is distinguished structurally as indicated in the key, and also by the lateral carina of the pronotum lacking the anterior process. The apical sternite in male is more broadly rounded at apex than in *errabundus* and the hypopygial claspers are knobbed at apices as shown in figure 9. No other species so far as we know has this last structural peculiarity. The wings are as in *errabundus* but the hind pair are not spotted apically (fig. 10). Apical antennal segment about half as long as preapical. One or two of the basal ventral spines on fore femur quite prominent.

Length, 4–4.5 mm.

*Localities.*—Boston, Mass., Oct. 26, 1921, H. Biddle (Bost. Soc. Nat. Hist.); Pennsylvania, June, Uhler Coll. labeled as type of *Ploiaria maculata* Haldeman (U. S. N. M.); Plummer Island, Md., May 22, 1912, at light, E. A. Schwarz (U. S. N. M.); Kenilworth, D. C., July 26, 1912, O. Heidemann (Cornell Univ.); Eastern Branch, D. C., May 14, 1901, at light, A. Busck (Van Duzee); Maywood, Va., Oct. 16, 1915, W. L. McAtee (McAtee); Vienna, Va., Aug. 17, 1913, H. G. Barber (Barber); Falls Church, Va., May 27, July 20, 25, Aug. 2, 29, N. Banks (M. C. Z.); Falls Church, Va., July 20, N. Banks (Cornell Univ.); Falls Church, Va., Aug. 6, and no date (Van Duzee); Falls Church, Va., Aug. 7, N. Banks (Parshley); Falls Church, Va., Sept. 29, N. Banks (McAtee); Falls Church, Va., Aug. 22, N. Banks (U. S. N. M.); Berkeley, W. Va., Aug. 20, 1891 (Cornell Univ.); The Dalles, Ore., May 19 (Cornell Univ.).

With reference to the supposed type of *Ploiaria maculata* Haldeman listed above it is to be said that in Haldeman's first article the data for his specimen are given as "Pennsylvania, July," and in the second "Pennsylvania, June and July." Uhler tells us:[7] "Prof. Haldeman generously gave me the type of his description," but this specimen is the type of the second, not the original description. The latter, Haldeman informs us, was mutilated and now probably is lost.

This species, next to *errabundus*, is the commonest of the genus in America.

### EMPICORIS ERRABUNDUS (Say).

*Ploiaria errabunda* SAY, THOMAS. Descriptions of new species of Heteropterous Hemiptera of North America, 1831; Reprint Trans. N. Y. State Agr. Soc. 1857, p. 804; Complete Writings, vol. 1, 1859, p. 359 [North America].

*Ploiariodes tuberculata* BANKS, N. Emesidae, 1909, p. 46 [Sea Cliff, N. Y., Falls Church, Va.].

In addition to the characters mentioned in the key, this species has the venter with dense appressed white pile except on numerous small round areas at bases of the longer hairs which give it under a a moderate magnification the appearance of being spotted. The fore coxa is nearly as long as the pronotum, the cross-veins in the hind wing form an angulated line, both the veins closing the discal cell are curved so that the apex of the cell is drawn out into a rather long point, the stigma is spotted beyond the cross-vein (fig. 11), and the eighth sternite in the male has an obtusely pointed terminal process (fig. 12). The apical antennal segment is one-third as long as preapical. Fore tibia and tarsus as in figure 13.

Length: 4–4.5 mm.

Our most common and widely distributed species, represented in the material examined by the following collections: Paris, Me., July 4, 1916, C. A. Frost (Parshley); Monmouth, Me., July 27, 1912, C. A. Frost; Fall River, Mass., May 22, 1911, N. S. Easton (Bost. Soc. Nat. Hist.); Amherst, Mass., June 5, 1914; Cold Spring Harbor, New York, July 29, O. B. Meiner (Parshley); Sea Cliff, N. Y., Aug., N. Banks (M. C. Z.); White Plains, N. Y., Aug. 21, 1909 (Bueno); Penn Mar, Pa., July 15 (Cornell Univ.); Bedford Co., Pa., Aug. 8, O. Heidemann (Cornell Univ.); Bedford Co., Pa., Aug. (E. P. Van Duzee); Cropley, Md., April 27, 1910, laid eggs soon after capture, H. S. Barber (U.S.N.M.); Forest Glen, Md., July 14, 1915, at light, O. Heidemann (Cornell Univ.); Plummer Island, Md., May 7, 1916, R. C. Shannon (U.S.N.M.); Plummer

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[7] Proc. Boston Soc. Nat. Hist., vol. 19, p. 431, Nov. 1878.

Island, Md., May 21, 1910, Aug. 16, 1914, W. L. McAtee (Biol. Survey); Falls Church, Va., Aug. 7, Sept. 24 (type of *P. tuberculata* Banks), N. Banks (Mus. Comp. Zool.); Herndon, Va., Aug. 1911, H. G. Barber (Barber, Bueno, U.S.N.M.); Mount Vernon, Va., Aug. 20, 1916, W. L. McAtee (McAtee); Berkeley Springs, W. Va., Sept. 20, 1886 (Cornell Univ.); Thomasville, Ga., Mrs. A. P. Taylor (U.S.N.M.); Michigan (U.S.N.M.); Ridgeway, Ont., Aug. 7, 1886; E. P. Van Duzee (Iowa Agr. Coll.); Kansas (E. P. Van Duzee); Onaga, Kansas, F. F. Crevecoeur (U.S.N.M.); Texas, Uhler Coll. (U.S.N.M.); Dallas, Tex., June 7, 1907, F. C. Pratt (U.S.N.M.); Kerrville, Tex., June 19, 1907, F. C. Pratt (U.S.N.M.); Mexico (Cornell Univ.).

After a careful examination of all the American species available, and consideration of Say's original description, we have no doubt that this is the species Say had before him and not that here identified as *culiciformis* De Geer which has gone under the name *errabunda*. The present species has the small knob on the anterior end of lateral carina of prothorax, which Say specifically mentions ("the lateral carinate line of the thorax has a prominence like an obtuse spine before"), while the other never has it so far as we have been able to find. The fact that no mention was made by Say of the median process on middle of hind margin of pronotum may have been due either to his considering it of generic value or to oversight, the latter being not at all improbable as the tubercle is not conspicuous except when viewed from the side.

### Genus STENOLEMUS Signoret.

*Stenolemus* SIGNORET, V. Description d'un nonveau Genre de la Tribu des Longicoxes, Amyot et Serville. Ann. Soc. Ent. France, ser. 3, vol. 6, 1858, pp. 251–2, pl. 6, figs. 1–3 [Monobasic, *S. spiniventris*, new species, genotype.]

*Phantasmatophanes* KIRKALDY, G. W. A catalogue of the Hemiptera of Fiji, Proc. Linn. Soc. New South Wales, vol. 33, 1908, pp. 369–370, fig. 2 [Monobasic, *P. muiri*, new species, genotype.]

Emendation. *Stenolaemus*.

In species of this genus the labrum is closely adherent to base of rostrum and there is no spine between bases of antennae; the apices of the latter are more or less enlarged, ending in an acute process which may be more or less curved or angled. The prothorax is very variable in structure, but is always carried backward over mesonotum to the bases of wings, and is very noticeably constricted near middle, or pedicillate; there are great differences in the length of the pedicel connecting the anterior and posterior lobes. Some species have merely a constriction while others have a long pedicel. This difference is however not coordinated with any other outstanding structural character except in the case of *arizonensis* which has he venation of forewing different from that of the other species; ve consider this species entitled to subgeneric rank. The mesonotum nd metanotum each have a long spine on middle of hind margin. The male hypopygium is of the form shown in figure 16. Fore emur spinose from base, fore tarsus not heavily chitinized, short nd straight, with two distinct segments, hairy above and below; claws equal.

With the exception of *S. arizonensis* members of this genus are whitish to stramineous with brown to black markings of variable extent; their usual pale coloration and the abundance of long hairs on most parts of the body give them a habitus quite distinct among American genera. While the extent to which dark markings prevail is variable, the pattern is nearly the same throughout all of the subgenus *Stenolemus*. The principal features of these markings are the following: Bands differing in number, width and intensity, and sometimes in character of pubescence, and even of the supporting integument, on antennae and legs; two longitudinal vittae on top of anterior lobe of head; a band on each side of head from neck toward eyes dividing so as to leave the tubercles and a spot behind each eye pale; on prothorax a stripe nearly percurrent on lower surface, embracing most of pedicel, and sending a tongue posteriorly along side of posterior lobe, and anteriorly a band above front coxa, and a broad vitta each side of the median line on dorsum, these latter vittae interrupted by one or two pale stripes on outer side near base; mesothorax and metathorax largely dark, with pale edgings, and abdomen the same, more or less marked with pale. In most cases we have figured the forewings in order to give a clearer idea of their markings.

### KEY TO THE SUBGENERA AND SPECIES.

1. A distinct vein emitted from costal margin of basal discal cell of forewing (figs. 21, 23, 26, 29) (Subgenus **Stenolemus**)________________________ 2

No vein emitted from costal margin of basal discal cell of forewing (fig. 14); basal stout spine on posteroventral surface of fore femur directed downward, not angling towards base of femur; prothorax hardly pedunculate, anterior lobe gradually narrowed posteriorly, posterior lobe without tubercles on posterior margin; dorsum of head without post-sutural tubercles. Subgenus **Stenolemoides**, new subgenus, type species, **Luteva arizonensis** Banks____________________________________________________________(p. 28).

2. Basal spine of fore femur directed straight downward, not angling towards base of femur; prothorax deeply constricted but not pedunculate, anterior lobe quadrate, posterior lobe with four distinct tubercles near hind margin; subapical antennal segment longer than apical; fore tibia stout (fig. 17), barely longer than fore coxa and hardly as long as head and interior lobe of prothorax combined; mesothoracic and metathoracic spines short and stout, tapered apically____________________**pristinus**, new species (p. 29).

Basal spine of fore femur angling towards base of femur______________ 3

3. Prothorax not distinctly pedunculate, anterior lobe tapered posteriorly, tubercles on posterior lobe nearly obsolete; subapical antennal segment less than half as long as apical; fore tibia slender (fig. 20) about twice as long as fore coxa and as long as head and thorax combined; mesothoracic and metathoracic spines long and slender------**pallidipennis**, new species (p. 30).

Prothorax pedunculate, the peduncle sharply differentiated from the anterior and posterior swollen lobes and about as long as or longer than the former; posterior lobe with four tubercles near hind margin------------------ 4

4. Abdomen without submedian spines on venter in addition to the pedicillate spiracles; posterior discal cell bisected longitudinally by a distinct vein: basal and apical bands on hind femur brownish, the middle one deep black and very conspicuous------------------------**schwarzi** Bergroth (p. 30).

Abdomen with a pair of submedian spines on hind margin of sternites 3 to 5 or at least on 3 and 4 in addition to the pedicillate spiracles---------- 5

5. Submedian spines on venter distinguishable only on sternites 3 and 4, posterior discal cell not bisected by a longitudinal vein (fig. 24); all hind femoral dark bands broad and fuscous in color, not conspicuously dark pilose-----------------------------------**variatus**, new species (p. 31).

Submedian spines on abdomen present on sternites 3 to 5, inclusive----- 6

6. The small cross-vein behind basal discal cell in line with the posterior extremity of the vein closing that cell (fig. 25); submedian spines near hind margin of pronotum not acute, mere convexities on surface; posterior discal cell without longitudinal vein; dark bands on hind femora except the apical one very narrow------------------------**interstitialis**, new species (p. 31).

The small cross-vein behind basal discal cell distinctly proximad of the posterior extremity of the vein closing that cell (fig. 28); submedian spines near posterior margin of pronotum acute--------------------------- 7

7. Posterior discal cell of forewing bisected longitudinally by a distinct vein; mesothoracic and metathoracic spines not thickened near apices------ 8

Posterior discal cell of forewing *not* bisected by a distinct vein; mesothoracic and metathoracic spines more or less swollen near apices (figs. 31, 32); tubercles on hind lobe of head prominent, acute---------------- 9

8. Dark bands on hind femora broad, separated by about their own width, brown in color, the short hairs uniformly brown on all bands; bands on hind tibiae pale, third one from base especially so; sixth tergite without a pair of submedian spines at apex; wing venation as in figure 26; basal discal cell with two or three narrow whitish lines through the dark interior-------------------------------------**hirtipes**, new species (p. 32).

Dark bands on hind femora narrow, separated by much more than their own width, the basal bands black and black haired, the apical one golden haired; bands on hind tibiae all black; sixth tergite with a pair of submedian spines at apex; basal discal cell with numerous reticulating pale lines in dark part-----------------------**mexicanus**, new species (p. 32).

9. Portion of vein along inner margin of basal discal cell longer than the portion along same margin of posterior discal cell, and much arcuated basally (fig. 29); mesothoracic and metathoracic spines as in figure 31.
**spiniger**, new species (p. 33).

Portion of vein along inner margin of basal discal cell shorter than that along same margin of posterior discal cell, and but little arcuate basally; mesothoracic and metathoracic spines as in figure 32.
**perplexus**, new species (p. 33).

### NOTES ON PREVIOUSLY DESCRIBED SPECIES NOT INCLUDED IN THE FOREGOING KEY.

*spiniventris* (*Stenolemus*) SIGNORET, V. Ann. Soc. Ent. France, ser. 3, vol. 6, 1858, p. 253 [Mexico].

Apparently runs to that section of our key embracing the new species, *spiniger* and *perplexus*, but the meso- and meta-notal spines if properly figured, differ from those of either of these species or in fact from any we have seen. The mesonotal spine is represented as erect and acute and the metanotal, swollen at tip and curved so as to extend forward past the mesonotal spine.

### SYSTEMATIC ARRANGEMENT OF THE SPECIES.

- No cross vein emitted from costal margin of basal discal cell; basal spine of fore femur directed downward; posterior lobe of head and of pronotum without tubercles. (Subgenus *Stenolemoides*) ---------------- **arizonensis.**
- A cross vein emitted from costal margin of basal discal cell; posterior lobe of head and of pronotum with tubercles (Subgenus *Stenolemus*).
  - Prothorax deeply constricted but not pedunculate.
    - Basal spine of fore femur directed downward ---------- **pristinus.**
    - Basal spine of fore femur directed basad ------------ **pallidipennis.**
  - Prothorax pedunculate; basal spine of fore femur directed basad.
    - Abdomen without submedian ventral spines ------------ **schwarzi.**
    - Abdomen with submedian ventral spines.
      - **variatus.**
      - **interstitialis.**
      - **hirtipes.**
      - **mexicanus.**
      - **spiniger.**
      - **perplexus.**

### STENOLEMOIDES, new subgenus.

Differs from subgenus *Stenolemus* in the venation of fore and hind wings as shown in figures 14 and 15, the basal discal cell in former having no vein emitted from its costal margin. The basal spine of posteroventral series on fore femur is directed downward and not sloped towards base of femur as in most species of *Stenolemus*. *Type species.*—*Luteva arizonensis* Banks, N. (Emesidae 1909, p. 45).

### STENOLEMUS (STENOLEMOIDES) ARIZONENSIS (Banks).

*Luteva arizonensis* BANKS, N., Emesidae, 1909, p. 45 [Palmerlee, Arizona].

A pale brownish yellow species, without distinct markings on forewings. Basal two antennal segments with a few whitish annuli. Anterior third or more of posterior lobe of pronotum whitish, posterior margin subfuscous. Anterior femora and tibiae faintly whitish annulate, mid and hind femora each with six whitish annuli. Most of the veins of fore wings paler than the membrane.

Head about as wide as long on dorsum, eyes large, the posterior lobe slightly bulbous above and neither tuberculate nor sulcate. Anterior lobe of prothorax about 1.5 as long as wide, much tapered posteriorly, barely half as wide at posterior as at anterior margin, dorsum arched, posterior lobe slightly widened posteriorly, a little longer than anterior lobe, with a broad shallow median depression, posterior width less than greatest length, no tubercles near posterior margin. Legs less elongate and hairy than usual in the genus; fore tibia and tarsus as in figure 18. Hypopygium as in figure 16.

Length, 8-9 mm.

Data for specimens examined: Arizona, C. U. Lot 34 (Uhler Coll.); Oracle, Ariz., July 23; Yerington, Nev., July 13, J. P. Baumberger; Los Angeles, Calif., August (U.S.N.M.). The holotype also was examined (M. C. Z.).

## Subgenus STENOLEMUS Signoret.

### STENOLEMUS PRISTINUS, new species.

*Female.*—Head, anterior lobe of prothorax, and abdomen conspicuously marked and clouded with brownish fuscous and the fore wings almost entirely of that color, with the veins, some reticulating lines, and a few minute dots, whitish. The antennal, and femoral, and tibial annuli of mid and hind legs are very pale brown and, with the exception of the preapical one on each femur, inconspicuous; front coxa with 2, and front femora and tibiae with 4 rather conspicuous brown bands.

Head broader than long, eyes large, covering much more than half the entire length of side of head, transverse suture on dorsum not very deep, posterior lobe with two small but sharp processes on dorsum anteriorly; antennae much stouter than usual, with long hairs, third segment fully as long as fourth. Anterior lobe of prothorax subquadrate, not tapered, separated from posterior lobe by a deep constriction, posterior lobe widened from anterior to posterior margin, with four distinct but not very large tubercles near posterior margin; mesothoracic and metathoracic spines comparatively short and stout. Spines on fore legs much shorter than in any of the other species, the basal one not bent towards base of femur (fig. 17). Abdomen elongate ovate, third, fourth, and fifth tergites each with an angular projection near posterior lateral angles; venter without submedian spines, spiracles elevated. Posterior discal cell of fore wing with a longitudinal vein bisecting it, vein emitted by basal discal cell not as close to base as in next species, the cell acute at base.

Length, 7.5 mm.

*Holotype.*—Key West, Fla., April 9, E. A. Schwarz (U.S.N.M.).

The fore tibia in this species has about three series of minute subdecumbent black setulae on venter, while in *pallidipennis* it has two series, one anteroventral and the other posteroventral, which consist of much longer suberect spines of unequal lengths alternating. All the other species of the genus in this paper have the anteroventral series complete (*arizonensis*), or that series complete and the posteroventral series present on at least the apical half of tibia.

*Type.*—Female, Cat. No. 26707, U.S.N.M.

### STENOLEMUS PALLIDIPENNIS, new species.

*Male.*—Much paler than the other species of the genus, the general color stramineous, the femoral annuli very indistinct, and the wing markings pale fuscous.

Head as broad as long, arched above, the posterior lobe slightly tumid on each side of median line anteriorly; basal antennal segment and base of second segment above very long haired, third segment not one-third as long as fourth. Profile of head and thorax as in figure 19. Anterior lobe of prothorax not longer than its greatest width, anterior lateral angles tumid, narrowed posteriorly, and separated from posterior lobe by a deep constriction, posterior lobe gradually widened from anterior to posterior margin, about 1.5 times as long as anterior lobe and as long as wide, the four tubercles before hind margin barely evident; mesothoracic and metathoracic spines slender, curved, the pointed apices directed forward. Venter lacking submedian processes, the spiracles slightly elevated and situated very close to lateral margins; hypopygium not large, almost covered on dorsum by the broadly rounded posterior projection of the apical tergite, claspers small, slender, curved. Venter and all femora and tibiae with very long fine hairs; fore femur with the postero-ventral spines longer and more widely spaced than usual, four or five of them conspicuously longer than the others, the basal one directed somewhat toward the base of femur (fig. 20). Venation as in figures 21 and 22.

Length, 8.5 mm.

*Holotype.*—Santa Rita Mountains, Ariz., June 12, 1898, E. A. Schwarz (U. S. N. M.).

*Type.*—Cat. No. 26708 U. S. N. M.

### STENOLEMUS SCHWARZI Bergroth.

*Stenolaemus schwarzi* BERGROTH, E. New and little known heteropterous Hemiptera in the United States National Museum, Proc., U. S. Nat. Mus., vol. 51, pp. 229–230, Oct. 28, 1916 [Tampico, Mex.].

This species, in common with most of those treated in this paper, has the forewing concave behind the apex (fig. 23), the degree of concavity varying with the species, the least occurring in *pallidipennis*.

The antennae and legs in *schwarzi* appear slightly thicker at the dark annuli and are also furnished with more dense blackish pubescence on these parts; thoracic spines piceous. Wings with the fuscous markings as seen with the naked eye consisting of two or three bands irrorated with whitish.

Head across eyes slightly broader than long, eye as wide as interocular space; posterior lobe with 2 moderate swellings on dorsum anteriorly. Anterior lobe of prothorax a little longer than the peduncle, posterior lobe rather abruptly widened, the posterior tubercles distinct. Basal and one other spine of the postero-ventral series on fore femur much longer than the others. Venation and markings of forewings as in figure 23. The male has the wings less extensively blackened, the disk being almost all white.

Length, 8–10 mm.

Redescribed from the type specimen, a female, No. 20149, U.S.N.M., Tampico, Mexico, Dec. 21, E. A. Schwarz, two males, Tegucigalpa, Honduras, July 25 and 26, 1917, and one female, La Ceiba, Honduras, September 27, 1916, F. J. Dyer (U.S.N.M.).

### STENOLEMUS VARIATUS, new species.

*Male.*—Mesothoracic spine pale, metathoracic one darker. Wings more evenly infuscated than in *schwarzi*, basal discal cell almost solid black, center of posterior discal cell with an amoeboid yellowish splotch. Hind femoral and tibial bands broader than in other species and lacking short dark hairs, the long hairs on the bands dark brown, those on other parts of femora and tibiae pale brown.

Tubercles on posterior lobe of head barely perceptible. Anterior lobe of prothorax a little longer than pedicel; processes near hind margin of posterior lobe elongate, acute; mesothoracic and metathoracic spines slender, of about equal size, blunt at tips, with rather long hairs. Abdomen as stated in key. Fore coxa a little longer than pedicel of prothorax, fore femur slightly curved, with normal armature. Basal discal cell of fore wing as in figure 24, apical discal cell not subdivided longitudinally, acute at apex.

Length, 10 mm.

*Holotype.*—Near San Ignacio, Misiones, Argentina, 1910, E. R. Wagner. (Paris Museum.)

### STENOLEMUS INTERSTITIALIS, new species.

*Male.*—General color as in *variatus* but the hind femoral and tibial bands are much narrower and paler.

Tubercles on posterior lobe of head small but rather acute. Anterior lobe of prothorax slightly shorter than pedicel; submedian tubercles on posterior lobe mere round swellings (the thorax is in poor condition owing to faulty pining); metathoracic spine slightly more thickened preapically than mesothoracic, both attenuated apically and rather densely long haired but not so pronouncedly so as in *spiniger*, submedian ventral spines long, posteriorly curved. Basal discal cell as in figure 25; apical discal cell lacking longitudinal dividing vein. Dark bands on hind femora separated by about twice their own width, lacking short dark hairs.

Length, 10 mm.

*Holotype.*—French Guiana, 1899, R. Oberthur (Paris Museum).

### STENOLEMUS HIRTIPES, new species.

*Female.*—Similar to *schwarzi* in color, rather paler, with the fore wings differently marked (fig. 26), and the antennal, femoral, and tibial annuli much paler.

In addition to the structural characters mentioned in the key the following are the principal characters possessed by this species: Head as broad as long, bituberculate on dorsum of posterior lobe anteriorly; basal antennal segment and base of second above very long haired, third segment about three-fifths as long as fourth. Anterior lobe of prothorax as long as peduncle, posterior lobe not abruptly widened, the tubercles large and rather sharp; mesothoracic and metathoracic spines erect and slender. Fore femur with only two of the postero-ventral spines conspicuously longer and stouter than the others; all legs, the prothorax, and venter densely and rather long haired. Fore tibia and tarsus as in figure 27.

Length, 9–10 mm.

*Holotype.*—Female, and two paratypes Mississippi, no other data, Coll. Ashmead (U.S.N.M.); one paratype, Miami, Fla., September 24, 1913, W. T. Davis (Davis); and another N. Landing, S. C., W. F. Fiske (U.S.N.M.).

*Type.*—Female, Cat. No. 26709, U.S.N.M.

### STENOLEMUS MEXICANUS, new species.

*Female.*—Head, thorax, and wings more extensively blackened than in other species of this subgenus, the markings on the wings much broken by narrow white lines and irregular dots.

Pedicel of prothorax a little longer than anterior lobe, posterior lobe with the 4 tubercles distinct; mesothoracic spine slender, tapered to apex, metathoracic one stouter and not so much tapered apically, both with rather inconspicuous hairs. Basal discal cell of forewings as in figure 28; a distinct, undulated, longitudinal vein through middle of posterior discal cell, as in *schwarzi*. Basal 2 bands on hind femora very narrow, middle one (deeper black) broader than these two combined and distinctly broader than either of the apical two; hind tibial bands except basal one about three times as long as tibial diameter; fore coxa a little longer than prothoracic pedicel; fore femur as thick as pedicel, the basal spine long, normal.

Length, 10 mm.

*Holotype.*—Frontera, Tabasco, Mexico, June, 1897, Townsend (Iowa State College).

### STENOLEMUS SPINIGER, new species.

*Male and female.*—Similar to *hirtipes* in color, the wings marked as in figure 29, but rather variable in intensity and form of markings. Besides the characters mentioned in the key, the peduncle of the prothorax is slightly longer than the anterior lobe (on dorsum) and distinctly tapered anteriorly (fig. 30), not equally thick the whole length as in *hirtipes;* the vein emitted by basal discal cell is longer and nearer base of cell than in that species, and there are three or four outstanding stout spines on the posteroventral surface of fore femur. Thoracic spines as in figure 31.

Length: 10–12 mm.

*Holotype.*—Male, Brownsville, Tex., May 21, 1904, H. S. Barber. Allotype, Brownsville, Tex., A. Jagow. Paratypes, one female, Escuintla, Guatemala, August, 1898, F. Knab; one female with label "Venedo" and no other data (U.S.N.M.); one female, Brownsville, Tex., Dorner (Ill. Nat. Hist. Survey); and a male, Motzorongo, V. C., Mexico, Feb. 11, 1892 (Iowa State College).

There is a small nymph from Brownsville, Tex., April 30, 1904, H. S. Barber (U.S.N.M.) which may belong to this species or to *hirtipes*, the presence of only two outstanding postero-ventral spines on fore femur apparently associating it with *hirtipes*, though we have seen no specimens of that species from Texas. The mesonotum and metanotum bear no spines; each abdominal tergite has a series of four long tubercles near posterior margin and numerous minute discal papillae, while each sternite has about eight small papillae along posterior margin.

*Type, allotype, and paratypes.*—Male, Cat. No. 26710, U.S.N.M.

### STENOLEMUS PERPLEXUS, new species.

*Male and female.*—Very similar in coloration and structure to *spiniger*, the dark color more intense as a rule. The pedicel of prothorax is longer, being distinctly longer than anterior lobe; the upper margin of male hypopygium between the claspers has no pronounced notch in center in *perplexus* while in *spiniger* it has. The other distinctions are as stated in key. Thoracic spines as in figure 32.

Length, 11 mm.

*Holotype.*—Male, El Campamento Col. Perene, Peru, June 21, 1920 (Cornell Univ. Exped., Lot 569). Allotype, Jatahy, Prov. Goyas, Brazil, 1889, H. Donckier (Paris Museum).

### Genus DELIASTES Dohrn.

*Deliastes* DOHRN, A. Nachträge, 1863, pp. 75–76 [Monobasic, *D. reticulatus*, new species, genotype, p. 76].

This genus differs from any known to us in having the fore tarsi heavily chitinized, bare above, and with but one oblique suture; the claws are unequal in size. The fore femur is spined from near base to apex, the basal spine longest; and the fore tibia has a series of setulae along the ventral surface which are stout at bases and are bent at right angles at middle, their apices directed toward apex of tibia. Second antennal segment slightly longer than first (13 : 12), third very short (0.75). Prothorax bilobate, in the winged forms the posterior lobe extending to bases of wings. Mesonotum and metanotum unspined; abdomen normal. Venation of fore wing as in figure 34; posterior discal cell with a nearly percurrent median longitudinal fold, simulating a vein.

The female of the genotype is wingless, and, like all apterous forms of Ploiariinae known to us, has the prothorax without a backwardly projecting flap overlying the dorsum of mesothorax. The abdomen is much broader than in male and with tergites 4–7 tuberculate posteriorly.

Through the kindness of Dr. M. S. Pennington, of Buenos Aires, we have received a specimen of *Deliastes brachmanni* Berg compared by him with the type. Study of this specimen in connection with the descriptions of Dohrn and Berg emboldens us to identify the genus which we had previously failed to do and to synonymize Berg's species with *reticulatus* Dohrn. There is a possibility of error here as Dohrn's description calls for reticulate venation of the hemelytra; however, because of the agreement of our specimens with the description in every other respect, we conclude that the "whitish veins" mentioned are only color markings, not true veins. Since Dohrn cites these "veins" as the principal distinction of *Deliastes* from *Palacus* it is probable that these are really only one genus. If this presumption is verified upon appeal to the types, the name *Palacus* will have the preference due to page priority.

KEY TO THE SPECIES.

1. Mid and hind femora dark brown or fuscous, each with two narrow stramineous annuli, one at one third of the length from apex and the other close to apex; mid and hind tibiae paler than femora, especially apically, a narrow band of fuscous marking off a pale band near base; antennae brown, with a narrow stramineous band near apex and another near base of first segment________________**reticulatus** Dohrn.

   Mid and hind femora and tibiae, pale stramineous, each hind femur with a small dark brown mark above at apex, the tibiae with a similar mark at base, mid femora with 2 brown marks on posterior side of apical half, mid tibiae with a narrow dark brown annulus near base; antennae pale stramineous, narrowly dark brown at bases and apices of first and second segments__________________________**stramineipes**, new species.

### DELIASTES RETICULATUS Dohrn.

*Deliastes reticulatus* DOHRN, A. Nachträge, 1863, p. 76 [Cuba].

*Deliastes brachmanni* BERG, C. Addenda et Emendanda ad Hemiptera Argentina, 1884, pp. 114–115 [Mendoza, Argentina].

*Male.*—Brownish fuscous, spotted and mottled with whitish. Fore femur with two irregular whitish annuli, fore tibia with a broad band on basal half and a narrower one on apical half, whitish. Fore wings brownish fuscous, reticulated with fine whitish lines; hind wings whitish hyaline.

Head very little longer than wide, convex above, the transverse constriction deep; eyes large, as wide as the distance between them; antennae without long hairs. Anterior lobe of prothorax a little shorter than posterior one, slightly tapered posteriorly, with no distinct constriction between it and the posterior lobe, its extreme length about twice its greatest width; posterior lobe arcuate both longitudinally and transversely, tapering anteriorly, greatest length about 1.5 times its greatest width, not tuberculate posteriorly. Apical tergite forming a broad lobe which extends to apex of hypopygium and almost entirely covers it, the apex bluntly rounded; upper posterior border of hypopygium as in figure 35; claspers long, slender, recurved apically; seventh sternite slightly concave posteriorly, not half as long as preceding one.

*Female.*—Similar to male in color, the abdomen with venter largely yellowish, marked with brown, more conspicuously on sides, the dorsum darker and with dark brown marbling over entire surface.

The eyes are much smaller than in male, being a little narrower above than the interocular space. The prothorax has a noticeable annular swelling just before its posterior margin and the margin is not flared; the mesonotum is distinctly humped posteriorly, with a median straight, and 2 lateral curved carinae; metanotum also tricarinate. Abdominal tergites 4 to 7 each with a median pointed tubercle on middle of hind margin, the intermediate two largest, posterior angles of connexivum angulate, most conspicuously so on segments 4 to 6; tergites 8 and 9 as in figure 36.

Length, 10–11 mm.

Male specimen compared with type of *brachmanni*, La Rioja, Argentina, M. S. Pennington (Pennington); 3 males and 3 females, Argentina, Chaco de Santiago del Estero, near Icano, E. R. Wagner (Paris Museum); one male, South America (Cornell Univ.).

There are three nymphs from the Paris Museum collection (with the same data as the adults) which agree in general characters of head, thorax, and legs with the female, but the claws of the fore tarsi are poorly differentiated, and there are no processes on dorsum of abdomen.

### DELIASTES STRAMINEIPES, new species.

*Male.*—Very similar to the male of the preceding species. Differs in color as stated in key and also in having the forewings more closely reticulated with whitish lines, and the process on upper margin of hypopygium as in figure 37.

Length, 11 mm.

*Holotype.*—Argentina. Chaco de Santiago de Estero, near Icano, E. R. Wagner (Paris Museum).

## Genus PANAMIA Kirkaldy.

*Panamia* Kirkaldy, G. W. Notes on Central American Hemipterous Fauna, Can. Ent., vol. 39, p. 249, July, 1907 [Monobasic, genotype, *Lutevopsis ornata* Champion].

This genus may readily be separated from its allies by the peculiar venation of the fore wings (fig. 38) and also by the characters mentioned in the generic key.

### PANAMIA ORNATA (Champion).

*Lutevopsis ornata* Champion, Biologia, vol. 2, pp. 166–7, Oct. 1896 [Bugaba, Panama].

*Panamia ornata* Kirkaldy, G. W. Notes on Central American Hemipterous Fauna, Can. Ent., vol. 39, p. 249, July 1907.

A pale testaceous yellow species, the pronotum sometimes with one or two short oblique brown streaks on each side, and a faint median vitta and sometimes 2 lateral clouds on posterior lobe. Fore wings with some faint fuscous spots, the most distinct, being one in extreme base of discal cell, one or more at middle of same, and one near the cross vein at its apex.

Head including eyes nearly as broad as long, rounded above (fig. 39); proboscis slender; antennal hairs not very long. Anterior lobe of prothorax smooth, slightly shining, a little tapered posteriorly, with a punctiform depression in middle posteriorly, the constriction between it and the posterior lobe shallow, length about 1.5 as great as its width; posterior lobe granular, slightly sulcate centrally, with four very slight elevations near posterior margin, length about 1.5 as great as width, slightly tapered anteriorly; mesonotum with a rounded central elevation, metanotum with a longitudinal ridge a little more prominent apically; first abdominal segment with a short, erect, spine. Abdomen slender, a little enlarged terminally; segment preceding hypopygium in male deeply concave both above and below, extending as a rounded flap on each side for about half the length of the rather large hypopygium, the latter open above posteriorly, the claspers slender and upturned apically on each side of the very slender and acute hypopygial spine, which exceeds them by about a third of its length (figs. 40, 41). Structure of hypopygium of female not very evident in the specimens at hand, the ventral valve somewhat inflated, capping over the end of the abdomen, the apical tergite with a rounded projection apically, and an emargination each side of it. Fore coxa about as long as prothorax and five-sixths as long as fore tibia; fore femur slender, about one fourth of its length longer than tibia, with about four minute stout postero-ventral thorns and short soft hairs; tibia lacking distinct armature; tarsus with two small slightly divergent claws. Venation of hind wing as in figure 42.

Length, 7–8 mm.

*Localities.*—Tabernilla, Canal Zone, Panama, April 27, 1907, A Busck. (U.S.N.M.); Chapada, Brazil, August, September, October (Carnegie Mus.).

### Genus LUTEVOPSIS Champion.

*Lutevopsis* CHAMPION, G. C. Biologia, vol. 2, pp. 165–6, Oct. 1898. [Included species *L. longimanus* and *L. ornata*, both new; Mexico and Panama].

This genus was originally erected for the reception of two species which Champion in his remarks on the genus points out "differ greatly, but they may be retained in the same genus for the present." We consider that the shape of the head, structure of the fore legs and their armature, and the venation of the fore wings are sufficiently distinct to warrant their assignment to different genera. For the venation of the fore wing of *Lutevopsis* (s. s.) see figure 43. The armature of the fore femur consists of moderately long thorns and intervening shorter setulae and hairs, while the fore tibia has a complete series of minute stubby denticles along the entire ventral surface as in *Gardena* (fig. 95).

*Genotype.*—*Lutevopsis longimanus* Champion.

#### LUTEVOPSIS LONGIMANUS Champion.

*Luteropsis longimanus* CHAMPION, G. C. Biologia, vol. 2, p. 166, Oct., 1898 [Chilpancingo, Mexico].

*Female.*—Reddish testaceous, shining, without distinct markings, the venter of the abdomen darkest, and the wings unmarked. Head over 1.5 times as long as wide, much tapered anteriorly, convex above, anterior lobe with a deep short central longitudinal cavity at posterior margin, the posterior lobe not sulcate (fig. 44). Anterior lobe of prothorax fully twice as long as its greatest width, gradually tapered from anterior to posterior margin, subopaque, with a slight linear sulcus posteriorly, posterior lobe subquadrate, about two-thirds as long as anterior, slightly elevated on each lateral angle and in center posteriorly. Abdominal spiracles slightly raised, no protuberances on tergites, the apical sternite convex at apex; seventh and eighth tergites polished, moderately convex apically, the former three times as long as latter. Fore legs rather slender, coxa about five sixths as long as tibia, the latter slightly curved. Venation of fore wing as in figure 43.

Length, 10 mm.

Locality, Istachatla, Fla., July 24, Heidemann Collection (U. S. N. M.).

We have had the opportunity of examining the type specimen of *Lutevopsis muscicapa* Bergroth through the kindness of its describer and find that it falls in the same genus as *longimanus* though the spines on fore femur do not extend as near to base, and the fore tibia is a little less than two-thirds as long as fore femur. It is a much darker species than the genotype, being brownish fuscous, with yellowish apical annulus on each hind femur (mid femora missing). Doctor Bergroth has expressed a doubt as to the region from which this species came. It is labelled "Borneo," but he suspects that it may really be South American.

### SPECIES NOT SEEN.

*L. chilensis* Porter, Carlos. Revista Chilena de Historia Natural, vol. 25 (1921) 1922, pp. 505–506 [Chile]. Seems too small for this genus.

### Genus EMESA Fabricius.

*Emesa* Fabricius, J. C. Systema Rhyngotorum secundum Ordines, Genera, Species, adiectis synonymis, locis, observationibus, descriptionibus. 1803, p. 263. [For a discussion of the genotype see below.]

*Westermannia* Dohrn, A., Emesina 1860, p. 251. [Includes three new species: *W. difficilis*, Colombia; *W. tenerrima*, Porto Rico; and *W. annulata*, Mexico, of which the last is here designated as the type species.]

*Westermannias* Kirkaldy, G. W. Biographical and Nomenclatorial Notes on the Hemiptera. The Entomologist, 1904, p. 280. New name for *Westermannia* Dohrn, 1860, preoccupied by Hübner's genus of the same name in the Lepidoptera, 1816.

F. L. de Laporte in his Essai d'une Classification Systematique de l'ordre des Hémiptères (Hémiptères Héteroptères Latreille), Guerin's Magasin de Zoologie, 1833 (p. 84), gives *Emesa mantis* Fabricius as sole example of this genus. It is customary to accept the first such mention of a single species in illustration of a genus as selection of a genotype. E. P. Van Duzee in his Catalogue of the Hemiptera of America North of Mexico, 1917 (p. 236), gives *E. precatorius* as the type by original designation, a view in which we are unable to concur. For a fuller discussion of the matter see Appendix 1.

Since the fate of the Fabrician genus *Emesa* and its component species underlies the nomenclature of the whole subfamily it may be well to give here a rather full discussion of the subject.

The genus *Emesa* originally included the following four species at the pages indicated in the Systema Rhyngotorum.

1. *filum*, Ent. Syst., vol. 4, 1794, p. 191. East India, p. 263.
2. *longipes*, Ent. Syst., vol. 4, 1794, p. 191. America, p. 263.
3. *mantis*, Ent. Syst., vol. 4, 1794, p. 190. Islands of America, p. 263.
4. *precatorius*, new species. Middle America, pp. 263–264.

The status of these species is discussed in the following paragraphs.

1. Unidentified by Dohrn (Emesina, 1860, p. 230) who shows that the references by Gray, Brullé, and Blanchard do not certainly apply to the insect Fabricius had. Distant's citation[8] adds nothing that would make definite the status of this species. Stal[9] queries *filum* showing that the type could not be found. We conclude that the species is entirely unidentifiable.

2. Stal[9] writes that *longipes* is a *Zelus*, thus removing it as a factor in taxonomy of the Ploiariinae.

3. The type of *mantis* recorded by Fabricius in his original description as being in the British Museum is still in that institution and in good condition. Through the kindness of W. E. China we are able to describe and illustrate it in this paper.

4. The *Emesa precatorius* of the Systema Rhyngotorum is not the *Gerris praecatorius* of the Entomologia Systematica (described from Guinea). The type is still is existence (Sehestedt Museum), and we have been furnished data concerning it by Dr. William Lundbeck. (See p. 82.)

Summarizing data as to the type species of *Emesa* Fabricius, it appears that *mantis* was at least acceptably selected by Laporte as the genotype. On the other hand it is only by a stretch of the imagination that *precatorius* can be considered the genotype. (See Appendix 1.)

The genus *Emesa* differs from *Stenolemus* in number of tarsal joints, in venation, and in having no long spines on either the mesonotum or metanotum, though the former has a central elevation and the latter an apical tubercle, sometimes pronounced. The genus *Myiophanes* Reuter is related to *Emesa* and we have figured the venation of the forewing (fig. 33) for comparative purposes.

### KEY TO THE SUBGENERA.

1. Fore tibia with a series of erect antero-ventral spinules which are about half as long as diameter of tibia, and between each pair of these two or more shorter spinules; fore femur as in *Stenolemus*, without a distinct break in antero-ventral series of spines near base, but the postero-ventral series curved ventrad at base so that the last long spine is almost in middle of ventral surface; venation of forewing as in figures 45, 46, 47; prothorax elongate pedunculate, two small round warts on disk of posterior lobe. **Emesa Fabricius (p. 40).**

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[8] Fauna British India, Rhynchota, vol. 2, 1904, p. 216.

[9] Hemiptera Fabriciana, vol. 2, 1869, p. 123.

Fore tibia either with a complete postero-ventral series of spinules mostly as long as, or longer than, tibial diameter, or with microscopic ventral denticles; venation of forewing as in figure 54; prothorax not pedunculate, without small warts on disk of posterior lobe 2

2. Fore femur with armature of postero-ventral surface consisting of short stout spines with black apices and between each pair and in line with them much shorter similar spines and longer fine bristles alternating, the antero-ventral series consisting of only short spines alternating with fine bristles, a rather wide break in the series near base, beyond which there are two short spines; fore tibia about two-thirds as long as femur, slightly ridged on ventral surface, the apex of the ridge with two series of minute denticles which are visible only under a high power lens; third antennal segment a little shorter than fourth **Myiagreutes** Bergroth (p. 42).

Fore femur with long fine bristles on postero-ventral surface, which are situated on short elevated bases and rather closely spaced, the antero-ventral surface with a similar series of shorter bristles which is interrupted near base, there being one or more bristles basad of the interruption 3

3. Fore tibia with a slight ridge along ventral surface which is surmounted by two series of short black denticles **Phasmatocoris** Breddin (p. 44).

Fore tibia with a single complete series of minute blunt denticles on ventral surface **Rothbergia**, new subgenus (p. 44).

## Subgenus EMESA Dohrn.

Bibliographical citation and type species same as for the genus.

### KEY TO THE SPECIES.

1. Basal discal cell large, distinctly longer than wide, interpolated between supplementary discal cell and posterior discal cell (fig. 45); anterior lobe of pronotum without sharp tubercle on each side anteriorly. **annulatus** (Dohrn) (p. 40).

Basal discal cell small or almost obsolete, when distinct much wider than long, supplementary discal cell abutting on base of posterior discal cell 2

2. Basal discal cell subobsolete (fig. 46); anterior lobe of pronotum with a sharply pointed tubercle on each side anteriorly; posterior lobe without spines **mantis** (Fabricius) (p. 41).

Basal discal cell distinct (fig. 47); anterior lobe of pronotum with a small rounded tubercle on each side anteriorly; posterior lobe with a conical acute spine on each humeral angle **marmoratus**, new species (p. 41).

### EMESA (EMESA) ANNULATUS (Dohrn).[10]

*Westermannia annulata* DOHRN, A. Emesina, 1860, p. 251 [Mexico].

We have not seen this species but have been favored by W. E. China with data and sketches drawn from the specimens in the British Museum identified as *annulata* by Champion. Our informant points out that the specimens agree with Dohrn's Latin description of 1860 but not with the German one of 1863 (Nachträge, p. 49).

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[10] Apparently the name *Emesa* as a genus of Heteroptera must be considered masculine in gender since of the originally included species the only one with a termination indicating gender, namely *precatorius*, is masculine.

We reproduce Mr. China's sketches showing structural details of the species (figs. 45, 48, 49). The color of the forewing is brownish, with base, a band across basal discal cell, and the apex, much darker. The brown annulations on mid and hind femora and tibiae are as broad as, or broader than, the intervening pale spaces, whereas in the next two species they are narrower than the pale spaces.

Length, 28 mm.

Locality, Mexico.

### EMESA (EMESA) MANTIS (Fabricius).

*Gerris mantis* FABRICIUS, J. C. Ent. Syst., vol. 4, 1794, p. 190 [no locality]. In the Systema Rhyngotorum, 1803, p. 263, a locality, Islands of America is given.

*Westermannia mantis* CHAMPION, G. C. Ent. Mo. Mag., ser. 2, vol. 9, 1898, p. 258.

We have not seen this species but have been supplied with data and drawings from the type by W. E. China. We have thus been able to definitely identify the species. The principal structural characters are represented in Figures 46, 50, 51, 52.

The color of the forewings is similar to that of *marmoratus*, the most conspicuous marking being the rather broad white veins at base of outer discal cell which form an angulated mark across the middle of the wing; the base of costa also is white. Structurally similar to *marmoratus* except as stated in key.

Length, 20 mm.

The type is from Jamaica; there is a second specimen, also in the British Museum from Jamaica, which, according to Mr. China, agrees with the type in all characters.

### EMESA (EMESA) MARMORATUS, new species.

*Female.*—Dark brown, marked with yellowish white. Beak, antennae, and legs conspicuously annulated. Anterior lobe of prothorax mottled, the pedicel largely whitish above, with brown spots, black beneath; lateral carina of posterior lobe and a pair of small tubercles on disk whitish. Abdomen almost black, with a few yellowish white marks, the most conspicuous, being one on connexivum, and another on each sternite in front of spiracles, the spiracles whitish. Fore wings fuscous brown, mottled with darker, veins at base of discal cell and the anterior half of the one closing costal half of outer discal cell ivory white, the membrane near them hyaline.

Head longer than wide, hind lobe tapered posteriorly, with two slight dorsal humps. Anterior lobe of prothorax about two-thirds as long as pedicel, tapered posteriorly, not sulcate on dorsum, posterior lobe a little shorter than pedicel, tapered anteriorly, about 1.5 as long as wide, with a slight but distinct carina on each side, a sharp tubercle near each posterior lateral angle, a pair of very small submedian tubercles behind middle, and a shallow median sulcus anteriorly. Connexivum with prominent angulate flaps on segments 6 and 7, eighth tergite longer than ninth, broadly rounded. Fore femur slender, the shorter spines distinctly shorter than the femoral diameter. Venation of fore and hind wings as in figures 47 and 53, respectively.

*Male.*—Anterior lobe of pronotum a little less than half as long as pedicel, the fore legs longer and more slender than in female, the abdomen more extended beyond apices of wings, with the apical tergite tapering to tip, where it is rounded, its basal width about three-fourths as great as its median length, the hypopygial claspers curved, moderately stout and hairy, hind margin of hypopygium with a central erect pale spike broad at base.

Length, 13–20 mm.

*Holotype.*—Female, Cayamas, Cuba, March 14, E. A. Schwarz. Allotype, male, Uhler Collection (U. S. Nat. Mus.); paratype, female, much broken, without data (Bueno).

*Type and allotype.*—Cat. No. 26711, U.S.N.M.

### Subgenus MYIAGREUTES Bergroth.

*Myiagreutes* BERGROTH, E. New neotropical Ploeariinae, Psyche, vol. 18, 1911, pp. 15–16. [Monobasic, type species, *M. praecellens*, new species.]

#### KEY TO THE SPECIES.

1. Hind margin of pronotum with three long slender spines; more than four outstanding spines present on postero-ventral surface of fore femur, the distance between them distinctly less than the length of fore tarsus. **praecellens** (Bergroth) (p. 42).

Hind margin of pronotum without long spines, only indistinct rounded elevations present; four outstanding spines present in the postero-ventral series on fore femur, the distance between them equal to or greater than the length of fore tarsus________________________**minor**, new species (p. 43).

### EMESA (MYIAGREUTES) PRAECELLENS (Gergroth).

*Myiagreutes praecellens* BERGROTH, E. New neotropical Ploeariinae, Psyche, vol. 18, pp. 16–17 [French Guiana].

*Female.*—Black, variegated with brown and with yellowish white markings. Base and apex of first antennal segment whitish; beak annulated. Thoracic thorns, more or less of sides, hind margin of prothorax and sometimes two vittae connected thereto, disk of mesonotum, four marks on anterior margin of posterior lobe of prothorax, and a spot above each of the fore and mid coxae yellowish white. Abdomen with a spot on connexivum in front of each spiracle, and membrane surrounding the spiracles whitish. Legs castaneous, femora blackish apically, and with a broad whitish apical annulus, bases of tibiae each with a broad white annulus, the ground color immediately beyond almost black. Markings of fore wing as in figure 54. Coxal spots and bases of mid and hind tibiae sometimes touched with orange red.

Head about twice as long as wide, not tuberculate on dorsum, the median transverse constriction very deep. Anterior lobe of prothorax arcuate, tapered slightly posteriorly, about 1.75 as long as wide, faintly sulcate on dorsum and obliquely on sides, and with a pair of outwardly directed sharp thorns on anterior margin above; posterior lobe a little shorter than anterior, but little tapered anteriorly, as long as wide, with a broad shallow median sulcus, and three long slender thorns near posterior margin; mesonotum with a subtriangular elevation; metanotum with a short spine. Abdomen slightly sloped downward from apex of seventh tergite, the eighth in the form of a broadly rounded lobe which at center is not over half as long as ninth tergite. Fore legs as stated in key, femora tapered at base and apex. Venation as in figures 54 and 55.

The male has the pale color markings rather more accentuated; the apical tergite has a broad, triangularly pointed process; hypopygium wanting in the specimen examined.

Length, 15–20 mm.

In addition to the holotype female from French Guiana, kindly submitted by Doctor Bergroth, we have seen two other female specimens from French Guiana (Bas Carsevenne, F. Geay, 1898; R. Oberthur, 1899) belonging to the Paris Museum, one male and one female from Para, Brazil, June (Carnegie Museum), and one female from Trinidad Rio, Panama, June 4, 1912, A. Busck (U.S.N.M.).

### EMESA (MYIAGREUTES) MINOR, new species.

*Female.*—Much paler than the preceding species, the general color being ochreous without the conspicuous cream colored markings which are so evident on the thorax and abdomen in *praecellens*. The legs are paler and while the apices of femora and bases of tibiae are paler than the other parts the immediately adjacent areas do not show the dark brown annuli so conspicuous in *praecellens*. The forewings are missing in the type and but one hind wing remains, which has the same venation as *praecellens*. Structural characters other than those mentioned in key much the same as in *praecellens*.

Length, 12 mm.

*Holotype.*—Female, Chaco Austral, near Icano, Argentina, 1910, E. R. Wagner (Paris Museum).

### Subgenus PHASMATOCORIS Breddin.

*Phasmatocoris* BREDDIN, G. Neue Rhynchotenausbeute aus Süd-Amerika, Societas entomologica, vol. 18, No. 19, Jan. 1, 1904, p. 148. [Monobasic, type species *P. spectrum*, new species.]

This subgenus is very closely related to *Myiagreutes* having the same venation and structure of fore tibia. In the armature of the fore femur, however, it agrees with *Rothbergia*, new subgenus, next described, though there are about 3 bristles instead of one basad of the interruption of the antero-ventral series. Only one species is known.

### EMESA (PHASMATOCORIS) SPECTRUM (Breddin).

*Phasmatocoris spectrum* BREDDIN, G. Neue Rhynchotenausbeute aus Süd-Amerika„ Societas entomologica, vol. 18, No. 19, Jan. 1, 1904, pp. 148–149 [Bolivia].

*Male.*—Reddish brown, including the fore-wings, the bases of the latter between the veins, and the extreme apices of mid and hind femora and tibiae are cream colored.

Fore coxa and tibia subequal in length, each about four-sevenths as long as fore femur. Eye not as wide as interocular space; posterior lobe of head rounded above. Pronotum with a short, round tubercle on each side of anterior margin; anterior lobe almost parallel-sided, as long as posterior lobe, separated from latter by a deep constriction; posterior lobe slightly concave in center of disk, with 3 short wart-like tubercles posteriorly. Hypopygium as in figure 56. Fore wing almost identical in appearance with that of *E. praecellens* (fig. 54).

Length, 20 mm.

Bolivia (Berlin Mus.). Redescribed from the holotype kindly sent to us for examination by Dr. Walther Horn. Another specimen from same collection which reached us in fragments is labeled Yungas de la Paz, Bolivia, 100 m., Breddin.

### ROTHBERGIA, new subgenus.

*Genotype.*—*Emesa testaceus*, new species.

#### KEY TO THE SPECIES.

1. Ventral spines on fore femur ceasing about the length of tarsus from base of femur (slender hairs basad of this point); anterior lobe of prothorax longer than posterior lobe (27:22), slightly narrowed posteriorly when seen from above (fig. 57); basal discal cells of forewing as in figure 58.
**rapax**, new species (p. 45).
Ventral spines on fore femur extending to or almost to base of femur__ 2

2. Basal discal cells of forewings as in figure 59; prothorax similar to that of *rapax* (fig. 57), but the anterior lobe is not narrowed posteriorly.
testaceus, new species (p. 45).
Basal discal cells of forewings as in figure 60; prothorax shorter than in preceding species, the anterior lobe declivitous in front (fig. 61).
diffinis, new species (p. 46).

### EMESA (ROTHBERGIA) TESTACEUS, new species.

*Female.*—Pale brownish testaceous, without distinguishable markings.

Head a little longer than wide, tylus forming a ridge in front of eyes, posterior lobe with a slight median hump just behind constriction; basal segment of beak over half as long as second; second antennal segment not two thirds as long as first, third nearly as long as fourth, third and fourth combined over three fourths as long as second. Anterior lobe of prothorax not narrowed posteriorly, arcuate, with a tubercle in front each side of the neck and a percurrent median longitudinal sulcus, about twice as wide as long, separated from posterior lobe by a deep constriction; fore coxal cavities slightly flaring, the prosternal sulcus almost vertical, pointed posteriorly; posterior lobe of prothorax about four fifths as long as anterior, subquadrate, without tubercles or distinct elevations; mesonotum and metanotum slightly elevated in center. Abdomen elongate, slightly ovate, tergites 1 to 7 broader than long, eighth very short, slightly rounded apically, about one fourth as long as seventh and over three times as broad as long, ninth longer than eighth, transverse at apex, disk depressed, margins and median line elevated. Fore femur stouter than usual, tapered apically, armature as stated in key; fore tibia well over half as long as femur (40:67) and equal to fore coxa; the three tarsal segments subequal in length, tarsal claws rather large, divergent. Venation of forewings much as in *Emesa praecellens*, basal cells as in figure 59.

Length, 11 mm.

*Holotype.*—Cacao, Trece Aguas, Guatemala, June, 1907, G. P. Goll (U.S.N.M.).

*Type.*—Female, Cat. No. 26712, U.S.N.M.

### EMESA (ROTHBERGIA) RAPAX, new species.

*Male.*—Similar in color to *testaceus;* differs as stated in the key. Apical tergite with a rounded flap extending over hypopygium, the latter opening upward, claspers rather short, pointed apically and slightly incurved, the process from hind margin of hypopygium erect, broad at base, thin and rounded apically. There is but one bristle on anteroventral surface of fore femur basad of the break in the series and this is situated at more than the length of the tarsus from the base of femur, the fore tibia is a little longer than half the entire length of femur (45:80) and a little shorter than fore coxae (50). Prothorax as in Figure 57; basal discal cells of forewing as in figure 58.

Length: 12 mm.

*Holotype.*—Tapia, Argentina, 2,000 feet, W. F. H. Rosenberg (U.S.N.M.).

*Type.*—Male, Cat. No. 26713, U.S.N.M.

### EMESA (ROTHBERGIA) DIFFINIS, new species.

*Female.*—A darker species than either of the others, the posterior lobe of pronotum, fore wings, and fore femora being largely infuscated.

The most noticeable structural difference is in the fore-shortened and declivitous pronotum which is illustrated in figure 61. The transverse constriction on head in this species is very shallow as compared with that of the others. Length of fore tibia as compared with fore femur 26 as to 45, of fore coxa 25. Basal discal cells of forewing as in figure 60.

Length, 9 mm.

*Holotype.*—Bolivia, W. M. Mann (U.S.N.M.).

*Type.*—Female, Cat. No. 26714, U.S.N.M.

### UNPLACED SPECIES.

*difficilis* (*Westermannia*) DOHRN, A. Emesina, 1860, p. 251 [Colombia].
*tenerrima* (*Westermannia*) DOHRN, A. Emesina. 1860, p. 251 [Porto Rico].

We are unable to place these species in our keys without fuller knowledge of the characters of their types.

We have been unable to enter into communication with the authorities who have the specimens in charge but W. E. China of the British Museum has supplied data dealing with the characters of the specimens that are identified as these species in that institution. Both have 3-segmented fore tarsi which would seem to ally them closely with *Emesa*, but the basal discal cell of forewings has a short vein emanating from it as in *Stenolemus* (fig. 62). The basal stout spine on ventral surface of fore femur is directed straight downward as in *Emesa* and the forewing is rounded at apex, not at all concave behind tip. In *tenerrima* the peduncle of prothorax is longer while in *difficilis* it is shorter than the anterior lobe. Mr. China also writes that the subapical antennal segment in *difficilis* is much longer than the apical. In the species of related genera examined by us this is never the case, the third being shorter than the fourth. There is, however, in some species a slightly indicated suture just before the apical swollen part of fourth segment which may be mistaken for a true joint, in which case the antenna would be considered as 5-segmented. This is, however, not really the case, the pseudosuture being almost indistinguishable in cleared material and much less so in dry specimens.

### Genus **POLAUCHENIA**, new genus.

Differs from *Emesa* in having only 2 discal cells in forewing (fig. 65) and in having the mesonotum and metanotum spined, and from *Stenolemus* in having the fore tarsi 3-segmented (fig. 64*a*), and in having no vein arising from the costal margin of the basal discal cell. The fore femur has the basal ventral spine directed downward and not sloped backward (fig. 64), the head has two pointed conical tubercles behind the transverse constriction and the posterior lateral angles of pronotum have divergent spines of moderate length.

*Genotype.—Polauchenia protentor*, new species.

#### KEY TO THE SPECIES.

1. Peduncle of prothorax but little longer than anterior lobe; posterior lobe of prothorax with two broader stramineous vittae; mid and hind tibiae each with two brown bands on basal half; preapical brown band on hind femur reduced to a small spot------------------**biannulata**, new species (p. 48).

Peduncle of prothorax about three times as long as anterior lobe (fig. 63); posterior lobe of prothorax with three narrower stramineous vittae on disk; mid and hind tibiae each with five brown bands on basal half; preapical brown band on hind femur broad----**protentor**, new species (p. 47).

### POLAUCHENIA PROTENTOR, new species.

*Female.*—Dark brown, marked with pale yellow. Basal and second antennal segments each with four pale annuli; basal two segments of beak pale at apices; prothorax with markings as in figure 63. Spines of mesothorax and metathorax pale. Abdomen fuscous, spiracles, lateral posterior angles of segments, and some linear marks on venter yellowish. Legs whitish yellow, each femur with five brown annuli; fore tibiae with four brown annuli, mid and hind pairs each with five brown annuli on basal half. Wings brown, darker apically, veins yellow, the membrane along the cross-veins, most of clavus, and base of corium whitish.

Head, antennae, prothorax, and fore coxae as in Figure 63. Fore femur a little less than twice as long as fore coxae, with armature as in figure 64; spines of mesothorax and metathorax short and straight, pubescent. Abdomen broadened slightly beyond middle, the tergites angulate laterally but without well developed lateral appendages; venter without submedian spines, spiracles but little elevated, not pedicillate, seventh pair not exposed. Hind femora about as long as head and body together, the tibiae distinctly longer, the hairs on legs of moderate length and not dense. Venation and shape of wing as in figure 65.

Length, 15 mm.

*Holotype.*—Tabernilla, Canal Zone, Panama, May 14, 1907, A. Busck (U.S.N.M.).

*Type.*—Female. Cat. No. 26715, U.S.N.M.

### POLAUCHENIA BIANNULATA, new species.

*Male.*—Similar in color to *protentor*, the prothorax bivittate instead of trivittate on disk posteriorly, and the mesothoracic and metathoracic spines black instead of yellow. The apices of forewings are not uniformly dark brown as in *protentor*, but have an elongate yellow mark with dark spotting in center about one-third of the width of wing. The principal color difference lies in the biannulate hind tibia, *protentor* having 5 brown annuli.

A much stouter species than *protentor*, the length of head and thorax combined being barely over two-thirds that of the abdomen, whereas in *protentor* they almost or quite equal the abdomen. The forewings (fig. 66) exceed the tip of abdomen and their posterior apical margin is but slightly concave. The head is much broader and shorter than in *protentor*, the interocular space is much narrower than one eye, the mesothoracic thorn is short, the metathoracic one longer, tapered, and neither very hairy. Venter about as in *protentor;* hypopygial claspers small, slender, and slightly upcurved apically.

Length, 16 mm.

*Holotype.*—Mana River, French Guiana, May, 1917 (Carnegie Mus.).

### Genus PLOIARIA Scopoli.

*Ploiaria* SCOPOLI, J. A. Deliciae Florae et Faunae Insubricae. Part 1, 1786, p. 60, pl. 24, fig. A (3 parts). [Monobasic *P. domestica*, new species, genotype, Austria.] Plate 23, Part 2, 1786, further (and better) illustrates the species and pp. 69–73 are devoted to an account of the habits and structure of the insect. Plate 25, figs. 1–5, Part 3, 1788, illustrate the egg and nymph, the latter with a strong submedian spine on front femur, a character the adult does not have.

*Cerascopus* HEINEKEN, C. Descriptions of a new genus of Hemiptera, and of a species of Hegeter. The Zoological Journal, No. 17, Jan.–May, 1829 (1830), pp. 36–40, pl. 2, fig. 5. [Monobasic, *C. marginatus*, new species, genotype, Madeira.]

*Emesodema* SPINOLA, MAXIMILIEN. Essai sur les Insectes Hémiptères, Rhyngotes ou Hetéroptères, 1840, p. 87 [founded on *Ploiaria domestica* Scopoli, hence an absolute synonym of *Ploiaria.*]

*Luteva* DOHRN, A. Emesina, 1860, pp. 242–3 [included species, all new; *L. concolor*, Celebes; *L. gundlachi*, Cuba; and *L. macrophthalmus*, Brazil and Colombia, of which the first named was subsequently designated as type by Van Duzee, Cat. Hemip. Amer. North of Mexico, 1917, p. 235].

*Ploiariopsis* CHAMPION, G. C. Biologia Centrali-Americana. Insecta. Rhynchota. Hemiptera-Heteroptera, vol. 2, p. 173, Oct. 1898. [Included species, both new: *P. megalops*, Panama; and *P. praedator*, Guatemala, of which the former was subsequently designated as type by Van Duzee, Cat. Hemip. 1917, p. 235.]

Emendation: *Ploearia.*

This genus shows in the structure of the fore tarsi an approach to the form of those of *Barce*, but in the armature of the fore femora there is a stronger resemblance to *Emesa* and its allies. In the winged forms of this genus the pronotum does not extend over dorsum of mesonotum except at the extreme anterior margin. The venation of the forewing is characteristic and in the hind wing there is immediately beyond the cross-vein a distinct thickening of the membrane and a slightly denser appearance similar to that of the costa extending almost across the field of the wing which is not found in any other genus in the subfamily so far as we know. The latter character is shown in figure 83. That we have here a group of closely allied species well regarded as belonging to a single genus is evident from the intergradation observable in what have been considered diagnostic characters. This is true not only of the armature of the fore legs, but also of the spines on the posterior lobe of the head. As for the presence or absence of hairs on the antennae it may be said that in this and some other genera the degree of development of these is a sexual character. If minor differences in the armature of the fore-legs and other characters of like importance are seized upon as justifying the recognition of additional genera, there will be almost no end to the process in a subfamily so rich in structural differences as the Ploiariinae.

To illustrate what would happen in the present genus if *Ploiaria* and *Luteva* were recognized as genera and the process carried to its logical end, *Ploiaria* would consist only of *domestica* and its closest allies; the species with two-spined trochanters would form a different genus; *Luteva* could not include a species with like femoral armature but with spined trochanter like *setulifera* here described; *Cerascopus* would be resurrected, and various segregates of one or a few species could be made on equally valid grounds. Generic importance has been claimed for a character, absence or presence of wings, which is not even of specific value in this group. Recognizing an excessive number of genera makes it difficult to construct and to use the generic key. When the genera approach the one-species standard the generic key becomes as difficult to use as an unusually long specific key. Is it not better to divide the burden between them? This can be done only by the recognition so far as practicable of genera which comprehend more species than the mere variants of a single specific type. If one gets off the track in a complicated generic key, he may soon go far into strange country; while with a simple key, after following an easy lead to the genus, even if he does find a key grouping a considerable number of related forms, he will at least be near his destination (that is, among forms truly related to that in hand). Winged and apterous specimens occur in the same species of *Ploiaria*, and it requires close observation at times to make certain whether apterous specimens are nymphs or adults. The full development of the genitalia and the three, instead of two, segmented tarsi, however, serve to identify adults in such cases.

### KEY TO THE SPECIES.

1. Fore trochanters with one or more spines (sometimes merely bristles), usually set on raised bases (the body of trochanter itself often acutely produced), never with numerous setae; fore femur with 4 to 7 stout spines which are always set on more or less distinctly enlarged and elevated bases, standing in line with or almost in line with a larger number of much smaller spines or bristles on the posteroventral surface, the longer spines sometimes with an outward curvature (fig. 80); apical antennal segment longer than subapical, never shorter than it; length of fore coxa variable in relation to length of fore tibia (Subgenus *Ploiaria*) ______ 2

Fore trochanters nearly bare or with few to numerous fine hairs, one or two of which are sometimes bristle-like; fore femur with the spines or bristles on the posteroventral surface more uniform in length, the larger bristles lacking enlarged elevated bases, and almost straight (fig. 74); apical antennal segment shorter than subapical, equal to it only in *setulifera;* fore coxa invariably longer than fore tibia (Subgenus *Luteva*) ______ 16

2. Posterior lobe of head with a prominent median backwardly projecting spine (fig. 85) ______ 3

Posterior lobe of head lacking spine ______ 4

3. Last tergite of male with a slender, obtuse, strap-shaped process extending back over hypopygium and closely adherent to it (fig. 86); hind margin of hypopygium as in figure 87; median process of seventh tergite of female extending distinctly farther caudad than the acute lateral angles (fig. 88).
**denticauda**, new species (p. 63).

Last tergite of male with a shorter, pointed process (fig. 92); hind margin of hypopygium as in figure 91; median process of seventh tergite of female extending but little farther caudad than the rounded lateral angles (fig. 90) ______ **hirticornis** (Banks) (p. 64).

4. Posterior lobe of head with an erect spinelet at margin of eye on each side behind constriction ______ **reticulata** (Baker) (p. 63).

Posterior lobe of head not so armed ______ 5

5. Posterior lobe of head with a more or less prominent median ridge ______ 6

Posterior lobe of head lacking such a ridge ______ 7

6. Posterior lobe of head with a slight central elevation anteriorly, and another posteriorly, between which there is a low longitudinal ridge; anterior lobe of head sulcate behind; fore coxa little longer than fore tibia; a highly colored species, beak with two dark bands, mid and hind femora fuscous apically, each with a subapical pale annulus, the corresponding tibiae fuscous basally, with subbasal pale annuli.
**granulata**, new species (p. 57).

Posterior lobe of head with a more or less distinct median carina. (This is true of *uniseriata* and *punctipes* which run on other characters beginning with next couplet ______ 7

7. Fore coxa shorter than fore tibia; wings entirely absent____________ 8
   Fore coxa as long as, or longer than, fore tibia; wings or wing pads present ____________ 9
8. The long spines on postero-ventral surface of fore femur forming a series distinctly laterad of the short setulae____**marginata** (Heineken) (p. 65).
   The long spines on posteroventral surfaces of fore femur in the same series as the short setulae____________**aptera**, new species (p. 66)
9. Fore coxa nearly twice as long as fore tibia (fig. 80); anterior lobe of head with a short but deep sulcus posteriorly; spines on fore femur distinctly longer than the femoral diammeter____________ 10
   Fore coxa but little longer than fore tibia; anterior lobe of head without a sulcus ____________ 12
10. Mesonotum rather depressed, with a broad elliptical sulcus extending nearly its entire length; only soft hairs between the strong postero-ventral spines on fore femur; thorax pale above; legs not banded; length 4 mm.; discal cell of fore wing as in figure 81, the inner apical part angulate.
    **uniseriata**, new species (p. 61).
    Mesonotum well arched both transversely and longitudinally, without median depression; legs banded; short spines between the strong postero-ventral spines on fore femur; larger species, darker colored; inner apical part of discal cell of forewings rounded (fig. 82)____________ 11
11. Male hypopygial claspers nearly as long as genital segment; length of insect 6 mm____________**punctipes**, new species (p. 62).
    Male hypopygial claspers much shorter than genital segment; length of insect 8 mm____________**similis**, new species (p. 62).
12. Distance between eyes on dorsum of head greater than the width of one eye; antennae short hispid or microscopically pubescent____________ 13
    Distance between eyes on dorsum of head not greater than width of one eye; basal two antennal segments distinctly hairy, the hairs longer than the diameter of segments____________ 14
13. Fore tarsus fully two-thirds as long as fore tibia; hind border of male hypopygium as in figure 75____________**carolina** (Herrich-Schäffer) (p. 58).
    Fore tarsus not two-thirds as long as fore tibia; hind border of male hypopygium as in figure 76____________**floridana** (Bergroth) (p. 59).
14. Wings whitish, without distinct markings; basal segment of antenna at least as long as entire insect____________ 14*a*
    Wings brownish, with dark markings; basal segment of antenna not as long as entire insect____________ 15

14*a*. Discal cell of forewing broad, not over 2.5 as long as its greatest width and about four-fifths as long as the vein emanating from its apex; cross-vein at two-fifths from apex of longitudinal vein.
    **albipennis**, new species (p. 60).
    Discal cell of forewing narrow, at least five times as long as its greatest width and a little longer than the vein emanating from its apex; cross-vein at not more than one-third from apex of longitudinal vein.
    **umbrarum**, new species (p. 60).
15. Antennal hairs but little longer than diameter of segments; hind border of male hypopygium as in figure 77____________**bispina**, new species (p. 59).
    Antennal hairs four or five times as long as the diameter of segments; hind border of male hypopygium as in figure 79.
    **pilicornis**, new species (p. 61).
16. Eye wider than interocular space (fig. 67)____________ 17
    Eye not wider than interocular space (fig. 72)____________ 19

17. Large pale species, over 10 mm. in length; antennae conspicuously hairy; fore femur with two brown annuli, one before and one beyond the middle; mid and hind femora yellow, whitish apically, with one broad preapical dark brown band; thorax largely yellow ventrally, more conspicuously blackened on dorsum than on venter____**macrophthalma** (Dohrn) (p. 53).
   Smaller, darker species, less than 10 mm. in length; fore femur with four brown annuli, including one at base and another at apex; mid and hind femora brown with one or two preapical pale annuli; thorax fuscous on venter________________________________________________ 18

18. Pronotum twice as long as its greatest width; venation of forewing as in *varipennis*, the vein leaving apex of discal cell undulated, crossvein near its middle; mid and hind femora each with 2 preapical pale annuli; fore trochanter with one outstanding bristle____**brunnea**, new species (p. 54).
   Pronotum about one third longer than its greatest width; discal cell of forewing as in *punctipes;* vein leaving apex of discal cell straight, cross-vein at one third length of that vein from apex; mid and hind femora each with 1 pale annulus; fore trochanter with two fine, rather widely separated outstanding bristles____________________**sicaria**, new species (p. 55).

19. Fore trochanter bare or with only soft hairs__________________________ 20
   Fore trochanter with soft hairs and a single outstanding bristle anteriorly; fore femora faintly banded, other legs nearly unicolorous, pale fuscous, knees narrowly pale_____________________**setulifera**, new species (p. 55).

20. Mid and hind femora each with a subapical dark or reddish band______ 21
   Mid and hind legs entirely pale____________**varipennis**, new species (p. 56).

21. Apical cross-vein of forewing at or close to middle of vein from apex of discal cell; the elongate dark mark in middle of discal cell rather faint.
   **gundlachi** (Dohrn) (p. 56).
   Apical cross-vein at one-third from base of vein from apex of discal cell; elongate dark mark in discal cell linear, almost black, appearing chitinized__________________________________**rufoannulata** (Bergroth) (p. 57).

REMARKS ON PREVIOUSLY DESCRIBED SPECIES OTHER THAN THOSE INCLUDED IN THE KEY.

*californiensis* (*Ploiaria*) BAKER, C. F. Pomona Coll. Journ. Ent., vol. 2, No. 2, May, 1910, pp. 226–7.[Claremont, Calif.]

May be the nymph of *P. reticulata* Baker. If adult it may be related to *P. marginata*.

*fairmairei* (*Emesodema*) DOHRN, A. Emesina, 1860, pp. 248–249 [West Indies].

*megalops* (*Ploiariopsis*) CHAMPION, G. C. Biologia, vol. 2, p. 174, Oct. 1898 [Volcan de Chiriqui, Panama].

Apparently *granulata* of our key is close to this species, which however has much larger eyes and pilose antennae; our species may prove to be the female of *megalops*.

*praedator* (*Ploiariopsis*), CHAMPION, G. C. Biologia, vol. 2, p. 174, Oct 1898 [Capetillo, Guatemala].

Agrees to some extent with our *uniseriata*, but the eyes are smaller, and the posterior lobe of head not sulcate anteriorly.

*sonoraensis* (*Ploiariopsis*), VAN DUZEE, E. P. Proc. Calif. Ac. Sci., ser. 4, vol. 12, No. 11, June 7, 1923, p. 144. [San Diego Id., Gulf of Calif.] Said to be allied to *megalops*.

*texana* (*Ploiaria*), BANKS, N. Emesidae, 1909, p. 44 [College Station, Tex.].

We have examined the type of this species (Mus. Comp. Zool.) and possibly we have renamed it in our *P. similis*. However, the abdomen of type is missing and the genitalia have neither been figured nor described; specific identification thus is impracticable.

### SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Fore trochanter of normal form, bare, pubescent, or with one or two bristles; spines of postero-ventral series of fore femur nearly uniform in length. Subgenus **Luteva**, sens. lat.

- **brunnea.**
- **sicaria.**
- **gundlachi.**
- **macrophthalma.**
- **rufoannulata.**
- **setulifera.**
- **varipennis.**

Fore trochanter often produced ventrally as a base for the 1 to 3 spines or bristles with which it is armed; spines of postero-ventral series of fore femur very unequal in size, sometimes in a double row. Subgenus **Ploiaria**, sens. lat.

- Wings or wing-pads present in adults.
    - Fore coxa subequal to fore tibia, hind lobe of head with a median ridge.
        - **granulata.**
    - Fore coxa longer than fore tibia. Hind lobe of head unarmed.
        - **albipennis.**
        - **bispina.**
        - **carolina.**
        - **floridana.**
        - **pilicornis.**
        - **umbrarum.**
        - Hind lobe of head with a median carina.
            - **punctipes.**
            - **similis.**
            - **uniseriata.**
        - Hind lobe of head with orbital spinelets.
            - **reticulata.**
        - Hind lobe of head with two tubercles and a median spine.
            - **denticauda.**
            - **hirticornis.**
- Wing pads absent in adults; fore coxa shorter than fore tibia.
    - **aptera.**
    - **marginata.**

### PLOIARIA MACROPHTHALMA (Dohrn).

*Luteva macrophthalmus* DOHRN, A. Emesina, 1860, pp. 244–5, pl. 1, figs. 23, 24 [Brazil; Colombia].

A pale brownish-testaceous species with conspicuous black eyes and dark brown to black marks on each side of pronotum and mesonotum, disk of metanotum, and on mesopleura. The fore femur has two brown annuli, one before and the other beyond the middle;

mid and hind femora each with a pre-apical and tibiae with a faint sub-basal brown annulus. Forewing with four dark brown clouds, one at base of discal cell, one on costa, and another on hind margin at middle of discal cell, and one on costa at extremity of transverse apical vein.

Head as in figure 67; apical antennal segment 0.75 as long as subapical, basal 2 segments long-haired. Pronotum slender, longer than mesonotum, gradually narrowed to near posterior margin, then rather abruptly widened; mesonotum slightly sulcate centrally. Hind margin of preapical abdominal tergite broadly concave; hypopygium of male without a central spine, the claspers long, very slender, overlapping and much curved, fanglike. Fore coxa 1.75 as long as pronotum and four-fifths as long as fore femur; trochanters pilose; femur slender, the armature consisting of fine slightly irregular spines; fore tibia half as long as femur and twice as long as fore tarsus, without erect ventral setulae; tip of tarsus falling considerably short of base of femur; mid and hind legs very long and slender. Discal cell of forewing ending in a narrow point (fig. 68).

Length, 11–12 mm.

Locality, Portobello, Panama, April 18, 1912, February 21, 1911, and March 12, 1911, A. Busck (U.S.N.M.)

### PLOIARIA BRUNNEA, new species.

A much darker species than *macrophthalma*, differing as stated in key and in having a much more noticeable white annulus at apex of each of the first two segments of antenna, that on basal one being much narrower.

Head as in figure 69, not so much narrowed posteriorly as in *macrophthalma*. Antennae and fore legs similar to those of preceding species in proportions. Pronotum and mesonotum slightly granulose and subopaque, not conspicuously shining as in *macrophthalma*, nor so gradually tapered.

Fore wing more conspicuously marked than in preceding species, the dark marks in cells more or less distinctly radiating from a central spot or streak. Apical tergite of male less concave than in preceding species, the hypopygium with a strong blunt upwardly directed protuberance in center, not conspicuously haired, the claspers stouter and more circularly curved, gradually tapered from base.

Length, 7 mm.

*Holotype.*—Male, Chapada, Brazil, June (Carnegie Mus.); allotype, Trinidad Rio, Panama, May 7, 1911, A. Busck (U.S.N.M.).

*Allotype.*—Female, Cat. No. 26716, U.S.N.M.

### PLOIARIA SICARIA, new species.

*Male.*—Coloration similar to that of *brunnea* but with the lateral margins and a carinate line on each side of disk of mesonotum, white; the costa of forewing is more extensively reddish, and the cell beyond the apical cross vein is entirely fuscous instead of only partly so.

Proportions of fore tibia and fore femur 20:35 (in *brunnea* 25:45); claws of fore tarsi slightly unequal as in *brunnea.* Upper margin of hypopygium similar to that of *bispina* (fig. 77) but the spines much shorter; claspers as in figure 70, more abruptly narrowed than in *brunnea.*

Length, 8 mm.

*Holotype.*—Huachi Beni, Bolivia, September, 1922, W. M. Mann. [Mulford Biological Expedition] (U.S.N.M.).

*Type.*—Cat. No. 26717 U.S.N.M.

### PLOIARIA SETULIFERA, new species.

*Female.*—A pale yellowish brown species without conspicuous markings, the apices of hind and mid femora whitish. Forewings with a few brown markings consisting of poorly defined spots or streaks, the most noticeable situated in middle of discal cell and just behind discal cell on inner side of wing.

Head similar to that of *pilicornis;* preapical and apical antennal segments about as in last two species as to proportions. Pronotum almost uniform in width to near posterior margin, where it is slightly flared, microscopically granulose and not sulcate; mesonotum with a very shallow broad central sulcus. Fore coxa about 1.5 as long as pronotum; fore trochanter with some fine hairs and one or two distinct, but short bristles; fore femur as in preceding two species; fore tibia half as long as femur, with a ventral series of decumbent setulae, which are directed apicad, very minute at base and becoming gradually longer apically; fore tarsus over three fourths as long as tibia, extending almost to base of femur.

Forewing as in figure 71.

Length, 8 mm.

*Holotype.*—West Lake, Cape Sable, Fla., February 26, 1919, A. Wetmore; Paradise Key, Fla., March 10, E. A. Schwarz and H. S. Barber (U.S.N.M.).

*Type.*—Female, Cat. No. 26718, U.S.N.M.

There are also three nymphs from the same localities which agree in most respects with the foregoing description. The wingpads are present, there are only two segments in the tarsi, and the armature of the fore legs is relatively stronger (especially in the bristling of the trochanter), more noticeably so in the younger specimens.

We have seen a species of this group, very closely related to *setulifera*, from Hong Kong, China, F. W. Terry (Bueno).

### PLOIARIA GUNDLACHI (Dohrn).

*Luteva gundlachi* DOHRN, A. Emesina, 1860, p. 244, pl. 1, fig. 19 [Cuba].

A pale yellowish species with more or less distinct dark brown markings. The most constant marks are on the mesonotum and before the apices of the mid and hind femora, the former having three rudimentary vittae and the latter a broad subapical band. The wings have more numerous brown spots than in the three preceding species, three on costa (one at base of discal cell, one about one third from base, and the other about one fourth from apex) being most conspicuous; there are two elongate marks, one in discal cell and the other beyond the cell between the longitudinal vein and hind margin, from which emanate brown linear markings giving the wing a reticulated appearance.

Head as in figure 72. Pronotum slightly longer than mesonotum, almost parallel-sided to near posterior margin, then dilated, not sulcate; mesonotum slightly widened posteriorly and like the pronotum, opaque and with fine decumbent pubescence. Hind border of male hypopygium without a central spine, furnished with many stiff, backwardly directed hairs on each side near bases of claspers, the latter slender apically, much curved and hairy. Fore legs as in the preceding species. Transverse apical vein a little less than midway between apex of discal cell and apex of wing.

Length, 9–10 mm.

Localities, Balthazar, Grenada, West Indies, H. H. Smith (U.S.N.M.); Cayenne, French Guiana, February, 1917 (Carnegie Mus.); Mayaguez, Porto Rico, July, 1914 (Amer. Mus.).

### PLOIARIA VARIPENNIS, new species.

Similar in color to the preceding species, but the preapical femoral band and mesonotal markings are very faint or absent. The markings of the forewings are darker, and of about the same pattern, but there is only one large dark brown spot on costa, namely, the one about one-third from base of discal cell, the others being very small and not more conspicuous than the other spots on wing.

Head as in *gundlachi*. Male hypopygium with a slight rounded central production of the hind border and with fewer and finer hairs than in last species, the claspers more abruptly curved. Fore wing as in figure 73. Fore legs as in figure 74.

Length, 10–11 mm.

*Holotype.*—A male; allotype, and five nymphs, Cacao, Trece Aguas, Alto Vera Paz, Guatemala, April 23. Paratype female, and one nymph, same locality, April 11, and four nymphs, April 2, 13, and 21, E. A. Schwarz and H. S. Barber (U.S.N.M.).

*Type, allotype, and paratype.*—Cat. No. 26719 U.S.N.M.

### PLOIARIA RUFOANNULATA (Bergroth).

*Luteva rufoannulata* BERGROTH, E. Psyche, vol. 18, No. 1, Feb. 1911, pp. 18–19 [Jamaica].

We have examined the type of this species. It is closely related to *gundlachi*, the principal distinctions being found in the wings. The markings of the forewings appear to furnish a ready means of identification. There are eight dark marks along costa, those opposite base, and middle of discal cell and the one at apex of the cross-vein being especially conspicuous, while there are two discal linear blackish brown marks that are especially prominent; one in discal cell and the other in the cell below the cross-vein; neither of these marks has radiating streaks emanating from it as is the case in *gundlachi*. Mid femur with a preapical reddish annulus, fore coxa with most of apical half, and fore femur with three bands of the same color.

The abdomen is missing in type so that we can not compare the genitalia with those of *gundlachi*, but in other structural characters the species are very close.

Length to tip of hemelytra, 9 mm.

*Holotype.*—Mandeville, Jamaica, E. P. Van Duzee (Van Duzee).

### PLOIARIA GRANULATA, new species.

*Female.*—A dark-colored species with pale legs, the latter very characteristically marked, with a narrow fuscous subapical annulus and a broader apical one on each mid and hind femur, and a moderately broad basal annulus on each mid and hind tibia which have a median whitish spot on outer side that does not entirely encircle the tibia. The antennae are yellowish, fuscous at bases and apices of segments, the basal segment with a broad subbasal whitish annulus. The swollen bases of fore femoral spines fuscous, the spines yellow.

Eyes small, about half as long as distance from their anterior margin to apex of head; anterior lobe of head with a slight elevation on each side of sulcus; apical antennal segment about 1.75 as long as subapical; head and pronotum minutely granulate, each granule surmounted by a microscopic hair. Wing pads present, the mesothoracic pair largest. Abdomen slightly ovate, each tergite slightly produced on each side posteriorly, the amount of production increasing gradually to tergite 6, a slight median process near posterior margin of each tergite from second to seventh, inclusive.

the largest on tergite 6. Fore coxa a little longer than pronotum, minutely granulose, each granule with a microscopic pale hair which is directed towards apex of coxa; fore trochanter with two thorns on elevated bases; fore femur curved outwardly at middle, upper surface granulose as in coxae, the elevated bases of long postero-ventral spines about as long as the femoral diameter, the longest spines at least twice as long as their bases, the short spines also with elevated bases, one or two between each pair of the longer spines and slightly nearer to ventral surface than that series, the spines of postero-ventral series are curved outward and those of the antero-ventral series inward so that the tibia lies entirely clear of them when it is placed against the under surface of the femur; fore tibia with a series of distinct semierect setulae along postero-ventral surface and a similar series of longer setulae on basal half of antero-ventral surface; fore tarsus about two-thirds as long as tibia, with some setulae along the postero-ventral margin of basal segment.

Length, 4–4.5 mm.

*Holotype.*—Female Cacao, Trece Aguas, Alta Vera Paz, Guatemala, April 20; paratype female topotypical, April 14, E. A. Schwarz and H. S. Barber (U.S.N.M.)

*Type and paratype.*—Female, Cat. No. 26720, U.S.N.M.

### PLOIARIA CAROLINA (Herrich-Schäffer).

*Emesodema carolina* HERRICH-SCHÄFFER, G. A. W. Die wanzenartigen Insecten, vol. 9, 1853, p. 8, fig. 936 [Carolina].

A dark brown species with a pale dorso-central line on head and thorax, the fore femora with fairly prominent pale annuli and the apices of mid and hind femora yellowish. The wings are brown and faintly marbled with darker brown, not distinctly reticulated with fine brown lines as in some other species; a darker spot in discal cell.

In the nymph there is a rather noticeable central elevation on anterior margin of posterior lobe of head, but in the mature specimens this is almost or entirely absent. The apterous forms have the pronotum tapered posteriorly and almost without a constriction before the hind margin on top, the sides somewhat flared; in the winged forms the hind margin is noticeably flared dorsally also. Male hypopygium with the hind border as in figure 75. Fore femur stout, with 6 or 7 long postero-ventral spines, the longest fully as long as the femoral diameter, the apical one well beyond middle of femur; fore tibia without readily distinguishable setulae, but somewhat densely haired.

Length, 4.5–5.5 mm.

Localities, Thomasville, Ga., May 6, 1912, male, Mrs. A. P. Taylor (U.S.N.M.); Wrightsville, N. C., April 16, 1916, female, W. T. Davis (Davis); Wilmington, N. C., one winged male, one apterous female, and one nymph, H. G. Barber (Barber).

### PLOIARIA FLORIDANA (Bergroth).

*Luteva floridana* BERGROTH, E. Two new American Ploeariinae (Hem., Reduviidae), Konowia, vol. 1, 1922, pp. 218–219, August 20, 1922 [Florida].

*Male.*—Very similar to the preceding species, differing as stated in the key. The pronotum is without the slight dorso-median sulcus of *carolina*, the eyes in the winged form are larger, and the longest spines on the postero-ventral surface of fore femur are not as long as the femoral diameter; fore tibia not so much expanded distally; central spine on posterior border of hypopygium apparently simple instead of paired (fig. 76). The forewing has the venation as in *denticauda* (fig. 89).

Length, 6 mm.

The type which we have examined, is from Florida (Van Duzee Coll.). We have the species also from Crescent City, Fla., Uhler Coll. (U.S.N.M.)

The crossvein connecting the apical longitudinal vein with costa is erroneously stated in the original description to be absent.

### PLOIARIA BISPINA, new species.

*Male.*—Almost uniformly pale brownish yellow, paler than *carolina*, the fore femur not annulate, mid and hind legs with apices of femora and bases of tibiae whitish. Wings pale brownish, somewhat mottled.

Width of head across eyes almost as great as its dorsal length. Pronotum a little shorter than mesonotum, very slightly sulcate centrally. Fore coxa 1.5 as long as pronotum, slender, not granulose; spines on postero-ventral surface of fore femur numerous, three or four between each pair of the longer spines, the latter not longer than the femoral diameter, the apical long spine very short and but little beyond middle of femur; ventral setulae on fore tibia distinct at least on apical half or more. Posterior border of hypopygium as in figure 77.

Length, 5.5–6.5 mm.

*Holotype.*—Male, Mexico, 2154, no other data, C. F. Baker (U.S.N.M.). Paratype, males, Bartica, British Guiana (Acad. Nat. Sci. Phila.); Para, Brazil, August (Carnegie Mus.).

Other specimens in poor condition, labelled Cuba, 181 (U.S.N.M. and Acad. Nat. Sci. Phila.).

*Type.*—Cat. No. 26721 U.S.N.M.

### PLOIARIA ALBIPENNIS, new species.

*Male.*—A pale stramineous species without conspicuous markings. The forewings are entirely unmarked, the veins on basal half slightly smoky, those on apical half very pale. The fore femora have a faint narrow preapical and a narrower and less distinct apical band brown, while the mid and hind pairs are pale brownish with a rather distinct preapical broad darker brown annulus; knees pale.

Basal segment of antenna long-haired, as long as 2+3, fourth about five-sixths as long as third. Fore coxa nearly as long as pronotum and mesonotum, and subequal to fore tibia; trochanter with two moderately strong spines, and a bristle; femur with about six outstanding spines, the intervening short spines set on elevated bases. A pair of slender spines inside of upper border of hypopygium as in *bispina*, the hypopygial claspers slender, abruptly curved near apex and pointed. Venation normal, discal cell about four-fifths as long as vein emanating from its apex, the latter distinctly curved, not reaching margin of wing, the cross vein nearly straight, at two-fifths length of posterior vein from apex.

Length, 7 mm.

*Holotype.*—Lower California, 1895, Diguet (Paris Mus.). Paratype, Frontera, Tabasco, Mexico, June, 1897, C. H. T. Townsend (Iowa).

### PLOIARIA UMBRARUM, new species.

*Male.*—Brownish testaceous, the wings apparently immaculate; and only the apices of hind femora and bases of hind tibia whitish. The specimens were preserved in alcohol which may have changed the coloring.

Width of head less than its length; interocular space less than width of one eye. Prothorax and mesothorax subequal. Hypopygium without strong paired spines inside the apical border, the claspers rather angularly bent at middle, with acutely pointed tips. Fore coxa fully as long as prothorax and mesothorax combined, and very slightly longer than fore tibia; armature of fore femur rather fine, the longest bristles at middle shorter than femoral diameter. Venation as stated in key.

Length, 7 mm.

*Holotype.*—And one paratype male, Mandeville, Jamaica, in a cave. (U.S.N.M.)

This is the only species of the subfamily from the New World which we have any record of as occurring in caves but there are several species so recorded from the Eastern Hemisphere.

*Type and paratype.*—Cat. No. 26722, U.S.N.M.

### PLOIARIA PILICORNIS, new species.

*Male.*—Similar to *bispina* in color but the fore femur has a faint subapical fuscous annulus.

The head is slightly broader than in *bispina* (fig. 78), the pronotum is not sulcate and is more constricted before the hind margin, the fore femora are stouter, the short spines are less numerous, the long spines are longer, the longest fully as long as the femoral diameter, and the apical one is at one-third the length of femur from apex. Hind border of hypopygium as in figure 79.

Length, 5.5 mm.

*Holotype.*—Higley, Ariz., June 27, 1917, E. G. Holt (U.S.N.M.).

*Type*—Cat. No. 26723 U.S.N.M.

### PLOIARIA UNISERIATA, new species.

*Male.*—Brownish fuscous, dorsum of mesonotum yellowish-testaceous, antennae and legs brown, not noticeably annulated. Wings with dusky reticulation and a more prominent spot in discal cell and in area of wing just posterior to it on inner side.

Eyes large, as high as head and nearly half its length, width of one above equal to space between them; posterior margin of anterior lobe of head and anterior margin of posterior lobe each with a short deep sulcus in center, on each side of which the surface is slightly tumid; antennae long-haired. Pronotum not much tapered, very slightly flared posteriorly; mesonotum gradually widened posteriorly, with a shallow median dorsal sulcus; mesonotum ending in a rounded knob; metanotum with the margin raised and three discal carinae. Fore coxa slender, about 1.25 as long as pronotum; trochanter with one long curved spine and one or two shorter bristles; femur curved, a little thicker than coxa, postero-ventral series of spines consisting of about six, their bases distinctly swollen, the longest more than twice as long as femoral diameter, the spines bent outward; ventral surface fine-haired, with a series of short erect setulae on median third; antero-ventral spines much shorter than postero-ventral, about seven in number, inwardly curved, a wider space in the series near base for the reception of the tarsus; tibia two-thirds as long as coxa, with fine setulae along antero-ventral surface which are about as long as tibial diameter; tarsus about as long as tibia, basal segment with microscopic setulae posteriorly (fig. 80). Transverse vein at one-third of the distance from tip of wing to apex of discal cell, the latter as in figure 81. Hypopygium rather long, black and polished medianly, claspers long and slender, much curved and tapered on apical half; apical tergite convex posteriorly.

*Female.*—Similar to the male in armature of the fore legs. The eyes are much smaller; there are only small wingpads present; the abdomen is much more robust, and there are small but distinct processes on middle of hind margins of tergites; seventh tergite horizontal, with a short, triangular median process, the margin concave, then angled each side of it; eighth tergite deflexed, narrowed toward apex, which is transverse.

Length, Male, 4 mm.; nymph, 3.5 mm.

*Holotype.*—Male, San Thomas, Brownsville, Tex., May 30, 1904; allotype, Brownsville, Tex., May 21, 1904, H. S. Barber (U.S.N.M.).

*Type and allotype.*—Cat. No. 26724 U.S.N.M.

### PLOIARIA PUNCTIPES, new species.

*Male.*—Brownish fuscous, with testaceous markings and gray pubescence on head and thorax. Legs and antennae testaceous-yellow, coxae and femora spotted and annulated with fuscous. Wings with fuscous markings much as in preceding species, but the dark spot in center of discal cell is more conspicuous and while in *uniseriata* there is an isolated dark spot just beyond apex of discal cell clear of the longitudinal vein in this species the spot touches the vein; markings somewhat more aggregated in clouds at apex of wing.

Posterior lobe of head not sulcate anteriorly, but with a low longitudinal median carina; subapical antennal segment fully three-fourths as long as apical. Pronotum narrower and longer than in *uniseriata*. Fore coxa slender, about 1.25 as long as pronotum; fore femur slender, slightly curved, long postero-ventral spines as in preceding species, but with one or two short spines between each pair of antero-ventral spines, a rather irregular series of short setulae ventrad of them; antero-ventral setulae on fore tibia very short; tibia and tarsus as in *uniseriata*. Apical sternite less than half as long as preceding one; hypopygium long, dark and polished medianly, claspers long, slender, much curved but not tapered, ending abruptly in a sharp point, posterior hypopygial border with a short stout spike. Discal cell of forewing and the hind wing as in figures 82 and 83.

Length, 6 mm.

*Holotype.*—La Chorrera, Panama, May 17, 1912, A. Busck (U.S.N.M.).

*Type.*—Male, Cat. No. 26725, U.S.N.M.

### PLOIARIA SIMILIS, new species.

*Male.*—Similar to the preceding species in color and structure, differing as stated in key, and in size. Forewings as in figure 84.

Length, 8 mm.

*Holotype.*—Los Borregas, Brownsville, Tex., May 23, 1904, H. S. Barber (U.S.N.M.).

*Type.*—Male, Cat. No. 26726, U.S.N.M.

### PLOIARIA RETICULATA (Baker).

*Ploiariopsis reticulata* BAKER, C. F. California Emesidae (Hemiptera), Pomona College Journal of Entomology, vol. 2, No. 2, May, 1910, pp. 225–6 [Claremont, Calif.].

*Male.*—Head and thorax testaceous yellow, mottled with fuscous. Antennae stramineous, basal segment fuscous at base and apex and with a rather broad subapical and a narrow apical whitish annulus; beak annulate. Mesonotum with 2 linear submedian brown vittae, laterad of these the disk is grayish, each lateral margin broadly brown. Abdomen black, faintly speckled with yellowish, spiracles white. Legs stramineous, fore pair mottled with blackish and rather imperfectly annulate, mid and hind femora with faint brownish dots on basal half and each with 3 broad brown annuli on apical half. Forewings with brownish fuscous markings, forming reticulations on the greater part of disk, the most distinct marks being 2 long blackish streaks, one in apical half of discal cell and the other beyond that cell and behind the longitudinal vein but distinctly clear of it, the hind margin of the vein narrowly brown.

Head about as broad as long, with a small sharp spike at eye margin just behind transverse dorsal constriction, and a small round protuberance behind eye on side of head; antennae long-haired, third segment fully as long as fourth. Pronotum slightly flared posteriorly. Hypopygium with a bifid process projecting upward inside of hind border, the claspers not very long, curved, tapered at apices.

Fore trochanters produced into an acute process below which is armed with 2 or 3 spines. Forewing with discal cell subequal in length to longitudinal vein beyond it, the transverse apical vein faint, situated at nearly three fourths of the distance from apex of discal cell to apex of wing, the longitudinal vein bent down apically.

Length, 9 mm.

Redescribed from a male paratype, Claremont, Calif., Metz (Cornell Univ.).

Dr. C. F. Baker reports the species common about Claremont.

### PLOIARIA DENTICAUDA, new species.

*Male.*—This species is colored like *granulata*, but the femoral and tibial annulation is much less distinct. Head as in figure 85.

In addition to the characters mentioned in the key it differs from *granulata* as follows: The fore coxae, fore femora, and pronotum are not granulose and haired as in that species, the postero-ventral spines on fore femur are in an almost regular series, the bases of the longer spines are pale, but little differentiated from the spines and both combined are but little longer than the femoral diameter; the fore tibia has the series of setulae on postero-ventral surface very weak and short and that on basal half of antero-ventral surface practically absent; the fore tarsi are as long as tibiae. The male hypopygium is as shown in figures 86 and 87, the tergites are not produced on sides and the processes on the middle of hind margins of tergites except the last one are very small. The series of males contains winged and subapterous specimens; the venation of the forewing is shown in figure 89.

*Female.*—Similar to the male but the apical tergites are as described in key (fig. 88), and the antennae are very short hispid instead of long-haired.

Length, 5–5.5 mm.

*Holotype.*—Male, Fort Yuma, Ariz., January 23, H. G. Hubbard; allotype, Palm Springs, Calif., February 7, H. G. Hubbard, paratypes same data as foregoing (U.S.N.M.); and Calipatria, Calif., November 28, 1921, E. R. Kalmbach (Biol. Survey). Broken specimens not designated as type material: Williams, Ariz., May 27 and June 9, E. A. Schwarz and H. S. Barber (U.S.N.M.).

*Type, allotype, and paratypes.*—Cat. No. 2672, U.S.N.M.

### PLOIARIA HIRTICORNIS (Banks).

*Ploiariopsis hirticornis* BANKS, N. Emesidae, 1909, p. 44 [Southern Pines, N. C.].

*Ploiaria carolina* BANKS, N. Emesidae, 1909, pp. 44–45 [Southern Pines, N. C.]. The female of *P. hirticornis.*

This species closely resembles the last in structure of the fore legs, but the coxae are more slender and nearly twice as long as the tibiae, the fore tarsi are as long as the tibiae, the elevated bases of the long spines of postero-ventral series are about as in the last species, white, and the spines are blackish; the pronotum is longer and narrower than in *granulosa*, the abdomen has no lateral projections on tergites and the dorsal tubercles are small anteriorly, increasing in size posteriorly; the seventh tergite of the female has the lateral angles slightly produced and a longer central process (fig. 90); the apical border of the male hypopygium is as in figure 91; apical tergite as in figure 92. All our specimens have minute wing pads except one male paratype which is fully winged; the wings are rather closely reticulated with fuscous, the heaviest markings being in discal cell and along hind side of vein emanating from it.

Length, 5–6 mm.

Localities, Mulligans Hill, D. C., December 10, 1916, H. S. Barber (U.S.N.M.); Southern Pines, N. C., December 28, 29, 1908, A. H. Manee, type material (McAtee, Mus. Comp. Zool.). The holotype examined.

An immature female from Shreveport, La. (Mus. Comp. Zool.) has the abdomen inflated, especially posteriorly, median tubercles on all tergites, that on five most prominent; eighth tergite concave apically, without process.

### PLOIARIA MARGINATA (Heineken).

*Cerascopus marginatus* HEINEKEN, C. Zool. Journ., Jan.-May, 1829 (1830), pp. 36-40, pl. 2, fig. 5 [Madeira].

*Cerascopus canariensis* NOUALHIER, MAURICE. Note sur le genre Ploiaria Scop. Reut. (Emesodema Spin., Cerascopus Hein.) et description de quatre especes nouvelles palearctiques. Rev. d'Ent., vol. 14, 1895, p. 168 [Canary Islands].

*Male.*—Brownish fuscous, with a longitudinal central line on head and thorax, two round spots on each lobe of head and upper sides of pronotum, the lateral margins of pronotum and mesonotum and ventral surface of head and thorax yellowish. Antennae and legs brownish yellow, darker just before apices of femora and yellowish at apices.

Antennae short-hispid, apical segment about 1.75 as long as subapical; eyes small, not occupying over half the height of head, and shorter than distance from their hind margin to posterior margin of head, surface of head microscopically granulose; fore coxa as long as pronotum and about two thirds as long as fore tibia, with microscopic subdecumbent hairs, but not granulose; fore femur stout, surface as in coxa, outer series of strong spines on posterodorsal surface numbering four or five, their bases elevated, their entire length not greater than diameter of femur, the inner series not interrupted opposite bases of the strong spines, consisting of many closely placed setulae; antero-ventral series with no isolated bristle at or near base as in the species which have the tarsus falling short of apex of coxa; tibia two thirds as long as femur, the antero-ventral and postero-ventral hairs short; tarsus extending to middle of trochanter, fully half as long as tibia, basal segment without evident setulae. Pronotum with a rounded low tubercle each side of neck, tapered posteriorly, constricted just behind anterior margin, widest in front of middle, a distinct constriction between pronotum and mesonotum, the latter widening to above coxal insertions, with a median linear sulcus and slight longitudinal ridge along each side of dorsum separating the pale color of disk from the dark sides. Abdominal tergites without processes, the spiracles on top of connexival fold, the apical tergite with hind margin rounded; hypopygium as in figure 93, the claspers farther from apex than in any of the other species seen and the apical hook larger.

*Female.*—Differs from male chiefly in character of abdomen, which is broader, especially apically and has the spiracles on outer side of connexival fold; widest part of abdomen about at the juncture of fourth and fifth tergites, sixth tergite somewhat narrowed apically the end slightly convex; seventh tergite semi-circular; eighth a little longer, depressed medianly and emarginate apically.

Length, 4.5–5.5 mm.

Data for specimens examined: La Valli Province, Buenos Aires, Argentina, May 15, 1920, B. S. Donaldson (McAtee); Brazil, on orchids, H. B. Shaw (U.S.N.M.); Teneriffe, Canary Ids., A. Cabrera; Laguna, Oct. 1, 1910 (Bueno).

### PLOIARIA APTERA, new species.

*Female.*—Much paler than *marginata*, the dorsum of thorax but little darker than the venter.

Head as in the preceding species, but the eyes comparatively larger and the subapical antennal segment appreciably longer than the apical. Fore coxae, femora, and tibiae similar in lengths to those of *marginata*, the postero-ventral long and short spines in an almost straight series, only two or three of the short spines between each pair of the long spines and none opposite their bases; there is an isolated spine near base on antero-ventral surface, the antero-ventral series of setulae on apical half of tibia is stronger than in *marginata*. Abdomen ovate, distorted in type, but evidently lacking well developed median processes on hind margins of tergites.

Length, 5.5 mm.

*Holotype.*—Female, Galiuro Mountains, Ariz., May 24, H. G. Hubbard (U. S. N. M.).

This and the preceding species lack wing pads, the present one having a very faint ridge on each posterior lateral angle of mesonotum and metanotum which may represent the wing pads. We know of no American species of this genus except these two in which the adults have neither wings nor wing pads.

### Genus GARDENA Dohrn.

*Gardena* DOHRN, A., Emesina, 1860, p. 214, monobasic, genotype *G. melinarthrum* Dohrn [Ceylon.]; Nachträge 1873. p. 64.—CHAMPION, G. C. Biologia vol. 2, p. 167, 1898.

As amplified in the Nachträge, Dohrn's characterization of *Gardena* may be accepted in the sense of Champion for American species. However, there remains one notable discrepancy to be explained; Dohrn describes the prothorax as being subequal in length to the mesothorax and metathorax together. Measured on the median dorsal surface the prothorax in American species is twice or more than twice as long as the other divisions of the thorax together. However, illustrations of Asiatic species show the same condition, so the discrepancy probably is due to error or is to be explained by difference in method of taking the measurements.

Characters common to all the American species besides those mentioned in the generic key are: head lacking spines, prothorax (measurements taken on dorsum) twice or more than twice as long as meso- and meta-thoraces taken together (even in wingless forms); the anterior division of prothorax is trumpet-shaped with a low tubercle each side in front and expands posteriorly in the winged forms into a capacious, inverted, scoop-shaped, highly polished portion which completely covers the mesothorax, hind margin usually somewhat concave with a slight median swelling, but there are notable departures from this character in some species; mesopleura and mesosternum highly polished, either subnude or with a bare stripe in front of coxa; hind margins of sternites 2–6 in both sexes more or less emarginate medianly and arcuate laterally, most pronouncedly so on 6; sixth sternite in males visible from above, forming apparently an almost complete body ring; in most species it is overlaid dorsally by a flap-like process of sixth tergite; the ninth sternite also is largely exposed dorsally, where it is divided by a broad V-shaped cleft open posteriorly (fig. 97, and others); the surface of hypopygial segments is polished; all of the legs and the antennae exceed the body in length; antennae of males with abundant long hairs decreasing in length and erectness distally; especially from middle of second segment; wing venation as in figure 94; fore tibia and tarsus as in figure 95.

Coloration in the genus is very uniform, the species being chiefly castaneous, darkest on front legs, prothorax, and genitalia; the mid and hind trochanters and knees are stramineous, the pale base of tibia being more or less interrupted by fuscous; the tegmina and wings in most cases are dusky hyaline, whitish at base.

### KEY TO THE SPECIES.

*Males.*

1. Cylindrical part of prothorax sulcate in center of dorsum posteriorly; hind lobe usually transversely wrinkled anteriorly____________________ 2
   Prothorax without sulcus; hind lobe usually not distinctly wrinkled____ 8
2. Hind margin of hypopygium more or less sinuate or emarginate in middle (figs. 96, 98, 102, 104); sixth tergite with a longer slender process (figs. 97, 108)____________________________________________________________ 3
   Hind margin of hypopygium practically straight (fig. 105); 7th tergite with a shorter, and usually more rounded process (figs. 109, 112)_________ 4
3. Supero-posterior angles of hypopygium strongly produced, projecting when viewed from behind, much above hind margin; median process of seventh tergite elongate, but falling considerably short of apex of hypopygium (fig. 97); hind margin of pronotum concave, with a slight median swelling.
   **americana Champion** (p. 69).

Supero-posterior angles of hypopygium elevated but little above hind margin; median process of seventh tergite elongate, falling but little short of apex of hypopygium (fig. 108); hind margin of pronotum undulated, extending farthest posteriorly on each side of median line.
**crispina**, new species (p. 70).

4. Apex of hypopygial clasper circularly curved, the supero-anterior angle not produced (fig. 106); fore femur not evidently banded.
**domitia**, new species (p. 71).

Apex of hypopygial clasper not circularly curved, the supero-anterior angle produced (figs. 99, 100, 101); fore femur with one or more bands----- 5

5. Clasper fitting into a groove which extends forward on the outer side below supero-posterior angle of hypopygium (fig. 111); posterior angle of clasper a weak hook, process of anterior angle much stouter (fig. 99).
**eutropia**, new species (p. 71).

Clasper not fitting into such a groove, and of different shape---------- 6

6. Both branches of clasper slender (fig. 100); supero-posterior angle of hypopygium spine like; hind lobe of pronotum almost smooth.
**marcia**, new species (p. 72).

Both branches of clasper stout (fig. 101); supero-posterior angle of hypopygium obtuse, not spine like------------------------------------ 7

7. Antennae copiously hairy; hind lobe of pronotum strongly wrinkled in front, granulate behind----------------------------**pipara**, new species (p. 72).

Antennae not hairy, hind lobe only slightly wrinkled in front and almost smooth behind-----------------------------**pyrallis**, new species (p. 73).

8. Hind margin of hypopygium with a sharp tooth on each side of a rounded median emargination (fig. 104); seventh tergite with a moderate, pointed median process (fig. 114)------------------**poppaea**, new species (p. 74).

Hind margin of hypopygium slightly or not at all emarginate, and lacking teeth; seventh tergite either convex or with a distinct process-------- 9

9. Hind lobe of pronotum much more than half as long as the less than usually slender anterior portion, bearing three pale yellow vittae; forewings almost uniform stramineous in color; seventh tergite with a broadly triangular process; clasper circularly curved similar to figure 106.
**agrippina**, new species (p. 73).

Hind lobe of pronotum not half as long as the very slender anterior portion, without pale vittae; hind margin nearly straight across, the declivity just anterior to hind margin slightly carinate medianly; bases of forewings much paler in color than remainder; seventh tergite convex posteriorly but not produced; clasper not circularly curved (fig. 103).
**faustina**, new species (p. 73).

*Females.*

1. Cylindrical part of prothorax sulcate in center of dorsum posteriorly; hind lobe distinctly transversely wrinkled anteriorly; seventh sternite more or less produced apically (figs. 110, 113)------------------------- 2

Prothorax without sulcus; hind lobe not distinctly transversely wrinkled; seventh sternite convex but not produced apically.
**faustina**, new species (p. 73).

2. Seventh sternite with a short rather acute process at middle of posterior margin (fig. 107); mid and hind femora each with a preapical as well as an apical pale band----------------------**messalina**, new species (p. 72).

Seventh sternite with a longer process (figs. 110, 113)--------------- 3

3. Mid and hind femora each with a preapical and an apical pale yellow band; process of seventh sternite long and slender, reaching nearly to apex of hypopygium ________________________________ pipara, new species (p. 72).
   Mid and hind femora lacking preapical pale band ______________________ 4
4. Process of seventh sternite broad, the apex rounded and not reaching apex of abdomen (fig. 113) ________________________ caesonia, new species (p. 70).
   Process of seventh sternite narrower, extending to apex of abdomen, and there somewhat upcurved (fig. 110) __________ domitia, new species (p. 71).

SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Cylindrical part of prothorax sulcate in center of dorsum posteriorly.

- **americana.**
- **caesonia.**
- **crispina.**
- **domitia.**
- **eutropia.**
- **marcia.**
- **messalina.**
- **pipara.**
- **pyrallis.**

Cylindrical part of prothorax not sulcate.

- **agrippina.**
- **faustina.**
- **poppaea.**

### GARDENA AMERICANA Champion.

*Gardena americana* CHAMPION, G. C., Biologia, vol. 2, pp. 167–8, pl. 10, fig. 12, 1898 (part).

We have not identified the female of this species but the males are rather paler in general color than most of the species, being yellowish-brown, castaneous on posterior expansion of prothorax, meso- and meta-thorax and genitalia; sternites 7 and 8 distinctly emarginate medianly and arcuate laterally; ninth sternite, or hypopygium, with the apical margin triangularly excised medianly (fig. 96) between the elevated supero-posterior angles, within which lie the terete, somewhat curved and capitate hairy claspers; the part of ninth sternite visible from above is longer than sixth tergite without its median process; the latter is ligulate, rounded apically and its length compared to the tergite is as 15 : 35 (fig. 97). Fore tibia and tarsus as in figure 95; fore wings as in figure 94.

Length, 18–20 mm.

Two specimens seen, one labeled only Cordoba in the Uhler Collection (U.S.N.M.), and the other collected by J. S. Hine at Mazatenango, Guatemala, February 3, 1905 (Ohio State Univ. Coll.).

It is only through the great kindness of W. E. China of the British Museum that we are enabled to announce this determination of *Gardena americana.* With a copy of our key in hand Mr. China has worked over the type series and informs us that the specimen figured in the Biologia Centrali-Americana (reference above) has been taken as the type and that it is the present species which we designated as No. 2 in the key sent to him. Mr. China has kindly furnished a report upon the entire British Museum series which is well worth recording.

### SERIES OF GARDENA AMERICANA CHAMPION IN THE BRITISH MUSEUM.

Mexico.
- 1, male, Atoyac, Vera Cruz equals species 2, that is, *americana.*
- 2, female, Atoyac, Vera Cruz equals species 6, that is, *caesonia.*
- 3–8, males, Teapa, Tabasco equals species 2, that is, *americana.*
- 9, female, Dos Arroyos, Guerrero equals species 6, that is, *caesonia.*
- 9*a*, female, Chilpancingo, Guerrero equals species 6, that is, *caesonia.*

Panama.
- 10–15, males and females, Bugaba equals species 4, that is, *faustina.*

Guatemala.
- 16, male, Teleman, Vera Paz; prothorax sulcated but hypopygium mutilated.
- 17, male, Mirandilla equals species 2, that is, *americana.* This is the type specimen figured in Biologia, vol. 2, pl. 10, fig. 12.

Colombia.
- 18, male, Mazo equals species 2, that is, *americana.*
- 19, male, locality illegible, equals species 2, that is, *americana.*

It is worth noting that the above tabulation agrees in the association of sexes as concerns species 4 (*faustina*); and it strongly indicates that species 6 (*caesonia*) is the female of *americana.* For the present, however, we will allow these forms to stand under different names.

### GARDENA CAESONIA, new species.

*Female.*—Eighth tergite only a third a long as wide, bluntly rounded apically; 9th longer than broad, almost parallel-sided viewed from above, truncate apically; process of 7th sternite long triangular, pointed (fig. 113).

Length, 20 mm.

*Holotype.*—Female, Guatemala (U.S.N.M.). Paratype, Frontera, Tabasco, Mexico, June, 1897, C. H. T. Townsend (Iowa).

*Type.*—Female, Cat. No. 26729, U.S.N.M.

### GARDENA CRISPINA, new species.

*Male.*—Coloration as described for the genus; hind margins of sternite 7 and 8 moderately emarginate medianly, of 7 slightly concave, and of 8 a little convex laterally; 9th sternite polished, its hind margin with a shallow rounded emargination (fig. 98); that part of 9th sternite visible from above shorter than 7th tergite without median process, the latter ligulate, rather pointed and nearly as long as remainder of its tergite, proportion to whole tergite as 18 is to 37, (fig. 108).

Length, 18 mm.

*Holotype.*—Male Turrialba, Costa Rica, Schild and Burgdorf (U. S.N.M.).

*Type.*—Male, Cat. No. 26730, U.S.N.M.

### GARDENA DOMITIA, new species.

*Male.*—Hypopygium strigate, not so shining as usual, part visible from above about as long as 7th tergite including process, the latter broad, rounded apically, its length compared to the whole tergite as 12 is to 27 (fig. 109); hind margin of hypopygium transverse (fig. 105); clasper as in figure 106.

*Female.*—Connexivum elevated posteriorly, pale-edged; 6th tergite rounded apically; 8th semi-circular in shape; 9th broad, somewhat inflated, depressed on each side apically; 7th sternite prominently inflated anteriorly, posterior process as described in key, the margins each side of it slightly sinuate. (fig. 110).

Length, 20–22 mm.

*Holotype.*—Male, allotype female, with genital segments well preserved, and another pair with them damaged, Pachitea, Peru. (Bueno).

*Paratypes.*—Male, Lower Mamore River, Bolivia, Dec. 1913, 2 females, La Juntas, Bolivia, Dec. 1913, Quatra Ojos, Nov. 1913, J. Steinbach (Carnegie Mus.)

### GARDENA EUTROPIA, new species.

*Male.*—Color about the same as in *pipara.* Process of 7th tergite of moderate length, in proportion to remainder of tergite as 2 is to 3, its apex rounded. Hind margin of 6th sternite with a broad and deep median emargination, and strong sinuations on each side; seventh and eighth sternites distinctly although shallowly concave medianly and convex laterally. Ninth sternite long, opening upward, the posterior margin straight; viewed from above the flaring part of cleft is short, bordered each side by a broad, sloping, truncate process, beneath which the claspers are withdrawn (fig. 111); claspers as described in key (fig. 99).

Length, 17 mm.

*Holotype.*—Male, Santarem, Brazil. (Carnegie Mus.)

### GARDENA MARCIA, new species.

*Male.*—Color as in *pipara;* posterior lobe of pronotum almost lacking transverse wrinkles. Lobe of seventh tergite very short, in proportion to remainder of tergite as 2 is to 5, broadly rounded. Hind margin of sixth sternite broadly and deeply emarginate medianly, arcuate laterally; seventh and eighth sternites shallowly concave medianly and convex laterally, the former nearly straight across. Ninth sternite short, opening posteriorly and upwardly, its hind margin nearly straight; cleft of upper surface opening gradually from the base (fig. 112), supero-posterior angles, produced, elevated and spinelike at apices, hollowed out beneath for reception of the claspers, which are as described in key (fig. 100).

Length, 14 mm.

*Holotype.*—Male, Santarem, Brazil. (Carnegie Mus.)

### GARDENA MESSALINA, new species.

*Female.*—Fore femora each with a faint subapical pale band; mid femora and tibiae each with two pale bands. Seventh tergite very slightly convex on hind margin, eighth moderately long, semi-elliptical; ninth very convex transversely, somewhat constricted near middle of exposed portion, rounded apically. Sixth sternite with a deep emargination posteriorly involving the entire hind border; seventh sternite long, with a short, median triangular process posteriorly (fig. 107) sides of hind margin slightly concave; eighth sternite broadly exposed on sides, profoundly emarginate in middle.

Length, 17 mm.

*Holotype.*—Female, Victoria, Texas. (U.S.N.M.).

*Type.*—Female, Cat. No. 26731, M.S.N.M.

This is a wingless but mature specimen, which, because of different leg markings is treated as a different species from *G. poppaea*, represented by a wingless male, also from Victoria.

### GARDENA PIPARA, new species.

*Male.*—Head and body chiefly castaneous, the appendages yellow-brown; apex of first antennal segment, two bands on front femur, apex of mid and hind femur and subapical annulus, bases of mid and hind tibia and sub-basal annulus paler; wings dusky fumose. Seventh tergite rather short, its body exceeding the short rounded lobe only as 3 is to 2. Seventh and eighth sternites shallowly emarginate medianly, convex laterally; ninth or hypopygium, long, opening upward and backward, the hind margin nearly straight, the supero-posterior angles moderately elevated, the expanded part of dorsal cleft short, claspers as described in key (fig. 101).

*Female.*—Coloration as in male. Seventh tergite broadly rounded, and narrowly abruptly declivate apically; eighth tergite short, rounded apically, almost horizontal; ninth tergite long, slightly inflated above, abruptly narrowed below; the apical half is transversely rounded, marked off by two oblique depressions, and the middle of apical margin is slightly excised. Seventh sternite rather prominently inflated subbasally, apical margin straight across except at middle, which is produced as a long, slender pointed process, reaching nearly to apex of body.

Length, 18–20 mm.

*Holotype.*—Male, Province del Sara, Bolivia, April 1913, J. Steinbach.

*Allotype and paratype.*—Two females, same locality, 350 meters elevation, December, 1912, J. Steinbach. Paratype, two females, Chapada, Brazil, June. (All these specimens in Carnegie Museum.) Paratype male, La Zanga, Paraguay, V. Benzon (Copenhagen Museum), and another, Santa Cruz, Bolivia, September, 1917 (Pennington).

### GARDENA PYRALLIS, new species.

*Male.*—Paler than *G. pipara*, the leg markings, etc., therefore not so distinct; hind lobe of pronotum much smoother as described in key; genitalia very similar.

Length, 16 mm.

*Holotype.*—Llanos, Venezuela, F. Geay (Paris Mus.).

### GARDENA AGGRIPINA, new species.

*Male.*—Paler in ground color and with more pale markings than is usual in the genus; fore femur with three distinct pale bands, and front legs with other pale areas; pronotum with a median broad, and two lateral narrow pale vittae on posterior lobe; wings stramineous almost throughout; mid and hind legs pale, the femora and tibiae each with a distinct sub-basal and another faint darker annulus. Hind margins of sternites 7 and 8 concave medianly, convex laterally, of 9 nearly straight, cleft of ninth sternite, as seen from above, about one-third the length of part dorsally exposed; process of seventh tergite, well-developed, rounded apically, length compared with that of remainder of tergite as 9 is to 17.

Length, 16 mm.

*Holotype.*—Provincio del Sara, Bolivia, 350 meters elevation, Dec. 1912, J. Steinbach (Carnegie Mus.).

### GARDENA FAUSTINA, new species.

*Male.*—Chiefly distinguished by the long and slender prothorax and the prominently convex but scarcely produced hind margin of tergite 7 (fig. 115); sternites 7 and 8 are concave medianly, convex laterally; part of sternite 9 exposed dorsally about as long as tergite 7, the V-shaped cleft short, the supero-posterior angles truncate, not elevated but somewhat flaring laterally, posterior margin shallowly emarginate medianly (fig. 102); clasper ending in a flattish hook the blade of which is long acuminate and directed upward (fig. 103).

*Female.*—The hind margin of 7th tergite is slightly convex, transverse; the 8th tergite is semi-elliptical and the ninth longer than wide, somewhat narrowed and bluntly rounded apically; the 7th sternite is moderately convex apically.

Length, 20–22 mm.

In this species the coxae and adjoining parts vary from yellow to black in color and the hind part of thorax and tip of abdomen are quite dark, contrasting strongly with the yellow-brown abdomen, front part of body, and legs.

*Holotype.*—Male, Porto Bello, Panama, Feb. 28, 1911, E. A. Schwarz; allotype female, Feb. 21, other data the same; paratype males, Porto Bello, Panama, Feb. 15, 28, 1911, A. Busck; Trinidad River, Panama, May 7, 1911, A. Busck. A male and female from Biologia series of "*americana*" are labelled, Bugaba, 800–1,500 feet, Champion, and Caldera, Panama, Champion, respectively. All preceding specimens in United States National Museum. Four females, Cacagualito, Colombia, May, and one from Chapada, Brazil, Sept. (Carnegie Mus.). One male, French Guiana, Nov., 1914, R. Benoist (Paris Mus.).

*Type, allotype* and *paratypes.*—Cat. No. 26732, U.S.N.M.

### GARDENA POPPAEA, new species.

*Male.*—Posterior margin of hypopygium with two teeth, the superoposterior angles considerably elevated (fig. 104), portion of this sternite visible from above as long as 7th tergite including process, the latter barely lapping base of V-shaped cleft of hypopygium, its length compared to entire tergite as 3 is to 8 (fig. 114); claspers retracted, their form unknown.

Length, 20 mm.

*Holotype.*—Male, Victoria, Tex., Feb. 1905, J. D. Mitchell (U.S.N.M.).

While this specimen is entirely wingless it is obviously mature.

*Type.*—Male, Cat. No. 26733, U.S.N.M.

### Genus EMESAYA, new name.

For *Emesa* of authors not of Laporte (1833, p. 84) who named *E. mantis* Fabricius as type. Since this species belongs to the genus subsequently called *Westermannias* the latter name therefore falls into synonymy, and the insects formely known as *Emesa* are left without a distinctive name. See fuller data under the name *Emesa* as accepted in this paper (p. 38).

*Genotype.*—*Ploiaria brevipennis* Say. For full reference see under *Emesaya brevipennis* Say (p. 78). This new name is intended to combine a reminder of the long familiar term with a tribute to the pioneer American naturalist Thomas Say.

Characters of the genus besides those mentioned in the key to genera are: Mid and hind legs and antennae longer than body; head without frontal spine, the transverse sulcus convex posteriorly, its ends in front of eyes, its middle course between them; prothorax in unwinged forms somewhat shorter than meso- and meta-thoraces together, in winged forms decidedly longer, expanded posteriorly and entirely covering dorsum of mesothorax, its hind margin more or less concave medianly; wings extending only to about middle of abdomen; sutures between tergites difficult to distinguish, those seen are straight; sixth tergite of male ending in a long apically rounded flap covering hypopygium; sutures between sternites convex anteriorly, that between 5 and 6 most so; hypopygium of male long, somewhat compressed, hind margin with a median process; in females the seventh tergite is approximately semi-circular in outline, the eighth is oblong, somewhat tapering apically, with the apex variously modified, yielding the most valuable characters for the separation of species; the connexivum is more elevated in females than in males. Structure of fore tibia and tarsus and venation of wings as in figures 136, 137, and 138, respectively.

Coloration in the genus is simple, the general tone varying from stramineous to reddish (erythrization being especially characteristic of maturity); the whole head and body has a fine short sericeous pubescence, bare spots and lines in which account for most of the apparent markings, as a line over anterior half of pronotum and head, forked in front of transverse constriction, a straight line under each eye, cirrhose maculations on pronotum, and dotting over both upper and lower surfaces of abdomen; the mesosternum and mesopleura are entirely sericeous, not glossy as in *Gardena*. The front legs are more or less dark spotted and the spines dark-tipped; at least the knees (femora-tibial joints) of mid and hind legs are pale, often there is another distinct pale band each side of this joint. When the antennae are not entirely pale the first segment is pale apically. The wings vary from stramineous to fuscous-hyaline, often paler at base.

### KEY TO THE SPECIES.

#### *Males.*

1. Hind margin of hypopygium without median process, nearly straight across. **manni**, new species (p. 83).

Hind margin of hypopygium with a median process, sometimes partly concealed by the claspers ---------- 2

2. Hind margin of hypopgyium nearly straight across, bearing on its inner side a process which extends upward and forward between (and usually concealed by) apices of claspers (fig. 121) ---------- 3

Hind margin of hypopygium produced, in the plane of its outer surface, into a process which is not concealed between apices of claspers ---------- 4

3. Clasper broadly concave on upper margin, swollen at base and expanded on inner side toward apex into a triangular lobe (fig. 133), not hairy. **pollex**, new species (p. 82).

Clasper convex on upper margin, neither swollen at base nor expanded laterally toward apex, hairy, the hairs on inner surface long and erect (fig. 122) ---------- **brevipennis** (Say) (p. 78).

4. Process tapering gradually from base, slender and pointed, a little recurved apically; clasper nearly terete, strongly curved and somewhat bulbous apically (figs. 130–131) ---------- **apiculata**, new species (p. 81).

Process notched on the sides at base, broadly expanding apically, with a terminal notch; clasper nearly straight, curved only near apex which is not bulbous (figs. 118, 119, 120) ---------- **incisa**, new species (p. 78).

#### *Females.*

1. Eighth tergite with the lateral angles produced considerably beyond middle of hind margin (fig. 123) ---------- 2

Eighth tergite with the lateral angles produced no farther than middle of hind margin, or rounded (figs. 129, 131*a*) ---------- 5

2. Seventh tergite with a pair of divergent carinae bounding disk, within and distinct from the ridges which divide the upper surface from the downfolded lateral portions of the tergite[11] (fig. 116) ---------- 3

Seventh tergite without such carinae ---------- 4

3. Fore femur about 7.5 mm. long; fore coxa hardly twice as long as head. **brevicoxa** (Banks) (p. 77).

Fore femur about 9 mm. long; fore coxa fully twice as long as head. **banksi**, new species (p. 77).

4. Hind margin of eighth tergite between the processes decidedly concave, the emargination broadly U-shaped; seventh and eighth tergites with a median longitudinal bare and slightly elevated line (fig. 127); side of eighth tergite subangulate posteriorly ---------- **lineata**, new species (p. 81).

Hind margin of eighth tergite between the processes nearly straight, the emargination nearly rectangular (fig. 123); seventh and eighth tergites lacking such a line; side of eighth tergite not at all angulate posteriorly (fig. 124) ---------- **brevipennis** (Say) (p. 78).

5. Hind margin of eighth tergite bisinuate, the lateral angles and median point about equally produced (fig. 129) ---------- **modica**, new species (p. 81).

Hind margin of eighth tergite with the lateral angles rounded and the median portion apiculate or much produced ---------- 6

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[11] In partially collapsed or distorted specimens, the seventh tergite is prone to fold along the lines of the lateral and central carinae; these accidental and usually unsymmetrical folds must not be mistaken for the true carinae which are clear-cut and symmetrical.

6. Median portion of hind margin of eighth tergite apiculate (fig. 131*a*).
**apiculata**, new species (p. 81).

Median portion of hind margin of eighth tergite produced in a rather long, keel-like process (figs. 134, 135) ______________ **pollex**, new species (p. 82).

### REMARKS ON PREVIOUSLY DESCRIBED SPECIES OTHER THAN THOSE INCLUDED IN THE KEY AND SYNONYMY.

*affinis* [*Emesa*] DOHRN, Emesina 1860, pp. 222–3 [Columbia].

No hypopygial characters mentioned; the color markings described in themselves have no significance; examination of type necessary to identification. Champion (Biologia, vol. 2, 1898, p. 168) synonymizes this species with *longipes* DE GEER=*brevipennis* SAY.

*longipes* [*Emesa*] FABRICIUS, Systema Rhyngotorum, 1803, p. 263 [America]. Stal refers this to *Zelus*. See p. 39.

### SYSTEMATIC ARRANGEMENT OF THE SPECIES.

(*Females only.*)

Eighth tergite with the lateral angles produced farther than middle of hind margin.
  Seventh tergite with a pair of divergent carinae. **brevicoxa.**
  **banksi.**
  Seventh tergite lacking such carinae. **brevipennis.**
  **lineata.**
Eighth tergite with lateral angles not so much produced or even rounded, median portion of this tergite more or less produced posteriorly.
  **modica.**
  **apiculata.**
  **pollex.**

### EMESAYA BREVICOXA (Banks).

*Emesa brevicoxa* BANKS, N. Emesidae, 1909, p. 48 [Los Angeles, Calif.].

Described from a single female which remains the unique representative of the form. This specimen, now in the Museum of Comparative Zoology has been studied in the course of the present revision. The carinae of seventh tergite, not mentioned in original description are very distinctive, grouping the species with the new form *banksi* described below. The coloration is scarcely different from that of *E. brevipennis;* however it was noted that the mid and hind tibiae are entirely pale except for a sub-basal dusky band on each. Approximate measurements are: Length of head and body together 29 mm.; of front coxa, 5 mm.; of front femur 7.5 mm.

### EMESAYA BANKSI, new species.

Agrees with *E. brevicoxa* Banks in carination of seventh tergite (fig. 116; lateral view of female hypopygium, fig. 117) but differs in measurements of front legs as indicated in key. The posterior lateral angles of eighth tergite are less produced than in *E. brevicoxa* and much less than in average specimens of *E. brevipennis*

Say. General color pale reddish-brown, short gray pubescence abundant; leg bands only faintly indicated.

Length about 29 mm.

*Holotype.*—Female, San Antonio, Texas, Sept. 18–27 (Museum of Comparative Zoology).

*Paratype.*—Female, vicinity of La Paz, Lower California, 1903, L. Diguet (Paris Mus.).

### EMESAYA INCISA, new species.

Somewhat smaller than *E. brevipennis*, and most of the specimens are paler than the average color in the genus, this being especially true of the legs and antennae; the dark annuli therefore unusually prominent.

*Male.*—Ground color stramineous, broad vittae on sides of head and posterior lobe of pronotum (sometimes whole of this expansion), dorsum of abdomen more or less, leg bands and dots fuscous. Genitalia as described in key (see figs. 118, 119, 120).

Length, 24–27 mm.

Males from Palm Springs, Calif., Feb. 25, H. G. Hubbard (holotype); Monclova, Mex., Nov. 23, 1909, E. A. Schwarz (U.S.N.M.); Higley, Ariz., July 10, 1917, E. G. Holt (Biol. Survey).

*Type and paratype.*—Male, Cat. No. 26734, U.S.N.M.

This may be the male of one of the preceding two species.

### EMESAYA BREVIPENNIS (Say).

*Ploiaria brevipennis* SAY, THOMAS. American Entomology, vol. 3, 1828, pp. 105–6, pl. 47 [Philadelphia]; Complete Writings, vol. 1, 1859, pp. 105–6.

*Cimex longipes* DE GEER, CHARLES. Memoires pour servir a l'Histoire des Insectes, vol. 3, 1773, pp. 352–4, pl. 35, figs. 16–17 [Pennsylvania]. This name though older than Say's is preoccupied by *Cimex longipes* Linnaeus, Systema Naturae, ed. 12, 1767, p. 724.

*Emesa filum?* GRIFFITH, EDWARD. The Animal Kingdom arranged in conformity with its organization, by the Baron Cuvier * * * with supplementary additions to each order by Edward Griffith, vol. 15, 1832, p. 244, pl. 97, fig. 3. [North America.] Index p. 786 states "*Emesa filum? Filum,* read *brevipennis* of Mr. Say."

*Emesa pia* AMYOT, C. B. J. and SERVILLE, A. Histoire naturelle des Insectes, 1843, p. 394. [Philadelphia.]

*Emesa pia* HERRICH-SCHÄFFER, G. A. W. Die wanzenartigen Insecten, IX, 1853, p. 114, fig. 937. [North America.]

*Dmesa choctawana* KIRKALDY, G. W. Hemiptera, Old and New, No. 2, Can. Ent., vol. 41, No. 11, Nov. 1909, p. 388. New name for *brevipennis* Dohrn not of Say. However, Dohrn's *brevipennis* probably is Say's species and no new name was required. The generic name an obvious typographical error.

#### KEY TO THE SUBSPECIES.

1. Processes of 8th tergite shorter and more rounded as seen from above; disk of tergite stramineous, with more copious and longer pubescence, giving it a sericeous appearance_______________________________________occidentalis.

Processes of 8th tergite longer, more slender and pointed; disk of tergite darker, pubescence shorter and sparser ---------- 2

2. Pale annuli on mid and hind legs tending to obsolescence, especially in males, often the knees only pale ---------- **australis.**

Full complement of pale leg markings usually evident in both sexes. **brevipennis.**

### EMESAYA BREVIPENNIS BREVIPENNIS (Say).

In general color this subspecies varies from rubiginous to fuscous with the pale leg markings distinct; nymphs and teneral specimens are paler, mature specimens redder or darker. Genitalia as described in key (figs. 121 to 124). Fore tibia and tarsus as in figure 136; wings as in figures 137, 138.

Length, 28–36 millimeters.

Many specimens have been examined from a range with the following States as its extremes: Massachusetts, Missouri, Florida, and Texas. The species has been recorded also from Iowa.

The eggs (fig. 125) of this species are about 2 millimeters in length, long-elliptical in outline, the opercle with a large central, truncately conical tubercle, the periphery of which is more or less eroded at the base; the main body of the egg is black in ground color, somewhat compressed and with longitudinal rows of membranous, saw-tooth-shaped exfoliations, the bases of which are almost continuous; these lines of projections are arranged more or less in concentric ellipses (if we may use the expression) on the flat sides of the egg. Specimens examined were laid by a female captured on Plummer Island, Md., October 6, 1912. This individual laid about 20 eggs before October 11. M. Faunce. Another female collected at the same locality by E. A. Schwarz and H. S. Barber, November 16, 1912, also laid eggs in confinement.

Nymphs about 6 millimeters long collected at Plummer Island, April 20, by H. S. Barber are pale ivory color with fuscous markings as follows: A slender vitta from base of antenna along side of head, interrupted at eye; two more or less interrupted vittae along sides of all divisions of thorax; a slender line along outside of each front coxa and trochanter; front femur with a short vitta and 2 partial bands; mid and hind femora and tibiae each with 2 bands near the knee; apex of abdomen below with 2 series of markings, each consisting of a dot and 2 dashes; spiracles black. The posterior lobe of head is much more swollen than in adult.

### EMESAYA BREVIPENNIS AUSTRALIS, new subspecies.

From the Gulf States southward to Panama occurs what seems to be a geographical race characterized by a strong tendency, which is almost universal among the males, to lack all pale leg markings except at knees. We have not been able to correlate this character with any structural differences, whether of genitalia or otherwise. although it is noticeable that in this form the processes of the eighth tergite often are shorter than in northern specimens.

The obvious question as to whether any of the several synonyms of *Emesa brevipennis* apply to this subspecies apparently must be answered in the negative. Two of these names, *longipes* De Geer and *pia* Amyot and Serville, were founded on specimens coming from the same State as Say's material, namely from Pennsylvania, where only one form is known to occur. *E. pia* Herrich-Schäffer has the characters of the old, not the new, subspecies, and *choctawana* Kirkaldy applies to a form agreeing in description with, and which probably is, true *E. brevipennis* Say. Dohrn's key[12] attributes the principal character of our new subspecies to *E. longipes* De Geer, but his fuller description (pp. 221–2), based on De Geer's type, contradicts the statement in the key; De Geer's description does not mention the character at all, and his name is unavailable, as we have noted in the synonymy.

Specimens of the new subspecies examined are:

*Holotype.*—Male, Taboga Island, Panama, Feb. 27, 1912. A. Busck; allotype, same locality and collector, June 14, 1911 (U.S. N.M.).

Paratypes with the following data: Taboga Island, Panama, June 14, 1911, Feb. 22, 27, 1912, A. Busck; Ancon, Canal Zone, Panama, A. H. Jennings; Limon, Canal Zone, Panama, Aug. 24, 1918, H. Morrison; Gamboa, Canal Zone, Panama, July 17, 1918, H. Dietz and J. Zetek; Panama, June 25, Wirt Robinson; Paraiso, C. Z., Panama, Jan. 28, 1911, E. A. Schwarz; Cacao Trece Aguas, Guatemala, April 8, E. A. Schwarz; Altenas, Costa Rica, Schild and Burgdorf; Anahuac, Tex., Nov. 8, 1918, H. S. Barber (U.S.N.M.); Orange, Tex., July, 1914, Wm. T. Davis (Davis); Spring Creek, Decatur Co., Ga., July, 1912; Bainbridge, Ga., July 15, 1912 (Cornell Univ.); Gainesville, Fla., July 20, 1918, C. J. Drake (Drake).

*Type, allotype, and paratypes.*—Male, Cat. No. 26735, U.S.N.M.

### EMESAYA BREVIPENNIS OCCIDENTALIS, new subspecies.

A pair of specimens from the Uhler Collection (U. S. Nat. Mus.) marked L. Cal. are selected as holotype (female) and allotype (male) of this subspecies. The general color is rufo-stramineous with all markings whether darker or paler much less noticeable than in *E. b. brevipennis.* Length 31–34 mm.

A paratype female from Palo Alto, Calif., July 25, 1892, W. G. Johnson (Cornell Univ.) agrees in hypopygial characters (fig. 126) but is much shorter (26 mm.) and somewhat darker in coloration.

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[12] Emesina, 1860, p. 217.

A female of the *brevipennis* complex from La Belle, Fla., April 28, 1912 (Amer. Mus.) has the 8th tergite merely concave posteriorly, the lateral angles not forming teat-like processes, but since a male collected at same place and time is not separable from *E. brevipennis* the unusual character of the female is attributed to individual variation.

### EMESAYA LINEATA, new species.

*Female.*—Knees of posterior two pairs of legs pale, the middle legs with, the hind legs without, a faint subbasal pale annulus on femur; legs in general pale, head and body dark reddish-brown. Apex of abdomen as in figure 127.

Length, 31 mm.

*Holotype.*—Female, Crescent City, Fla. Broken specimen (U.S.N.M.)

*Type.*—Female, Cat. No. 26736, U.S.N.M.

### EMESAYA MODICA, new species.

A dark species varying from reddish-brown to fuscous, the usual pale markings present, however; bare spots about setae on ventral surface of abdomen much less conspicuous than in *E. brevipennis;* hypopygium as described in key (figs. 128, 129).

Length, 33 mm.

*Holotype.*—Female, Cordoba, Mex., F. Knab. (U.S.N.M.)

*Type.*—Female, Cat. No. 26737, U.S.N.M.

Another female specimen probably of this species, but having the genitalia badly mashed is from Cachi, Costa Rica, April 27, 1910, C. H. Lankester (Acad. Sci. Phila.).

Length, 34 mm.

### EMESAYA APICULATA, new species.

*Male.*—General color deep castaneous, coxal margins, beak except apex, antennal tubercles, wedge-shaped markings behind and inside eyes, margins of posterior lobe of pronotum and connexivum ivory-colored. First joint of antenna pale at apex and near base. Legs in general much paler than body; front ones with the lower surfaces and a broad subterminal and narrower subbasal annulus on tibia, and two narrow annuli near apex of femur ivory color; mid and hind legs with apices of femora and bases of tibiae ivory, sharply contrasting with general color, the other annuli but faintly indicated. Wings dusky hyaline, scarcely paler at bases.

Hypopygium (fig. 130) of moderate length, opening upward, hind margin and claspers as described in key (fig. 131) hind margin of sixth sternite slightly concave medianly, more so laterally; seventh nearly straight across; process of sixth tergite long, but not quite reaching apex of hypopygium, almost parallel-sided for most of its length, a little constricted beyond middle, transversely wrinkled basally, rather abruptly narrowed, bluntly-pointed and punctate apically.

Length, 30–32 mm.

Specimens: Males, Province del Sara, Bolivia, December, 1913, J. Steinbach (Carnegie Museum, Acc. No. 5068); Buena Vista, Bolivia, J. Steinbach (Carnegie Mus. Acc. 5573); Rio Autuz, Amazon, September, Roman (Stockholm Mus.). The last specimen differs in having hind margin of sixth sternite convex instead of slightly concave medianly. A female nymph, E. Bolivia, J. Steinbach (Carnegie Mus., Acc. No. 5572) probably is this species; as usual with nymphs of the genus it is more profusely and boldly marked than the adults.

*Holotype.*—The first specimen listed.

An adult female, for geographical reasons regarded as belonging to this species, bears the following data: French Guiana, R. Oberthür, 1899 (Paris Mus.). It differs in coloration from the male only in being a little duller, the markings especially of the front legs being less contrasted. The seventh tergite is very broad apically, the whole margin of the disk a little swollen; eighth tergite strongly carinate along the nearly parallel sides of disk, the carinae thickest at base, each with deep impression basally, apex of tergite rounded subangulate medianly (figs. 131*a*, 132).

*Emesaya precatoria* (*Emesa precatorius* Fabricius, J. C.[13] [Middle America]), seems to be much like *E. apiculata.* We have been supplied, through the kindness of Dr. William Lundbeck, with sketches and notes relating to the type specimen, which differs chiefly from the species here described in the emargination of the male clasper (fig. 131*b*) and shape of the apical hypopygial process (fig. 131*c*).

### EMESAYA POLLEX, new species.

*Male.*—Chiefly castaneous, the legs and antennae paler; the tylus, middle of head just behind it, areas inside eyes and posterior lobe of thorax tending to be paler. Darkening of the disk of latter in some specimens gives the effect of pale marginal stripes. The connexivum is touched with luteous. Front tibia and femur with pale areas but scarcely banded; mid and hind femora with evident terminal and faint subterminal, tibiae with basal and subbasal, pale annuli. Tip of first antennal segment pale. Wings hyaline, a little denser at base.

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[13] Systema Rhyngotorum, 1803, pp. 263–264.

Hypopygium long, opening upward (fig. 132*a*); spine and claspers as described in key (fig. 133). Sixth sternite with a shallow rounded emargination medianly, the sides first convex, then concave, posteriorly; 7th sternite with hind margin of approximately the same shape, but lacking median emargination. Process of 6th tergite narrowing very gradually, rounded apically, not quite reaching apices of claspers.

Length, 23–26 mm.

*Holotype.*—Male, Corumba, Brazil, May (Carnegie Museum, Acc. No. 2966). Paratypes male, two, same locality as type, highlands in March; and another, Province del Sara, Bolivia, February, 1913, Steinbach (Carnegie Museum); male, Brazil, G. Fallon (Paris Mus.).

A female certainly of this species from Santarem, Brazil (Acc. No. 2966, Carnegie Mus.) is selected as allotype. Coloration agrees very closely with that of the male. The seventh tergite is somewhat narrowly rounded apically, and the eighth is rather compressed, deep-sided and pointed apically, otherwise as described in key and figured (figs. 134, 135). Another female, labeled merely Amazon River (Stockholm Mus.), and one Goyaz, Jatahy, Brazil, Breddin (Berlin Mus.).

### EMESAYA MANNI, new species.

General color castaneous, posterior lobe of pronotum, wings, and legs paler brown, the fore femur with a subapical and the fore tibia with two pale bands. Male hypopygium as noted in key, the claspers oblong, not touching each other apically, the extremity pointed within, apical tergite moderately pointed and slightly surpassing hypopygium. Length, 32 mm.

*Holotype.*—Male, Huachi Beni, Bolivia, September, 1921, Wm. M. Mann (U.S.N.M.).

*Type.*—Male, Cat. No. 26738, U.S.N.M.

## Genus METAPTERUS Costa.

*Metapterus*, COSTA, ACHILLE. Additamenta ad Centurias Cimicum Regni neapolitani. Atti del real Istit. d'Incorag. Sci. nat. Napoli. 1860, p. 10.

This is the only bibliographical reference in the paper not personally verified. We have been unable to find this publication in the largest scientific libraries in the United States. The genotype is *Metapterus linearis* Costa, whether by original designation or otherwise, we are unable to say.

*Barce*, STAL, C. Hemiptera Africana descripsit, vol. 3, 1865, pp. 162–163. [A genus without species here.] Analecta hemipterologica, Berliner Entomologische Zeitschrift, vol. 10, 1866, p. 168. [Monobasic, *B. annulipes*, new species, genotype.]

*Carambis* STAL, C. Hem. Afr. 3, 1865, p. 163. [A genus without species here.] Anal. hemip. Berlin Ent. Zeitschr., vol. 10, 1866, p. 168. [Monobasic, genotype, *Emesa caspica* Dohrn.] This synonymy clears up Stal's reference to specimens of *Carambis* from America. (Enum. Hemip. 2, 1872, p. 127.)

*Mantisoma*, ÎAKOVLEV, V. E. Materials for the entomological fauna of European Russia, Proc. Russian Ent. Soc., St. Petersburg, vol. 7, 1874, pp. 34–35, pl. 1, fig. 2. [Monobasic, genotype *M. aptera*, new species.] The citation of this genus from Horae Soc. Ent. Ross., sometimes seen, is, of course, incorrect.

In the form of the forelegs this genus resembles *Emesaya*, *Gardena*, and *Ghilianella*, but is readily distinguished from them by the characters indicated in the generic key (figs. 139, 141.). In the caudal elongation of the apical abdominal tergite of the male, which covers the dorsal surface of the hypopygium to or beyond the apex, the genus resembles some of the species in *Ghilianella*, but the cephalic and some other characters readily separate it from that genus. The venation of the forewings (fig. 142) is evidence of relationship to *Emesaya* and *Gardena*, but the fore tarsal structure and the form of the hypopygia are quite different and indicate that *Metapterus* is no more closely related to these genera than to *Ghilianella*. The apical antennal segment is at least four times as long as the subapical.

Our identification of *Barce* with *Metapterus* is based on comparison of the two type species, the specimens of *Metapterus linearis* in our hands being some identified by Dr. A. L. Montandon. The male hypopygium of this species has a longer central spine than in the most closely related American species (*uhleri*, *neglectus*) and this causes the last tergite to appear more decidedly arcuate. The hypopygial claspers are rectangularly bent at about midway to apices, the apical half projecting upward like the central thorn, whereas in the North American species the claspers are slightly or almost imperceptibly curved. The female of *M. linearis* resembles that of *uhleri* most closely, the apical tergite being without notch, and the sixth sternite without a broad central emargination; the apical tergite is broadly deflexed on apical half.

### KEY TO THE SPECIES.

#### *Males.*

1. Basal spine of postero-ventral series on fore femur less than its own length from base of femur; apical outline of hypopygium from side irregular (fig. 147) ---------- aberrans, new species (p. 86).
   Basal spine of postero-ventral series on fore femur more than its own length from base of femur; apical outline of hypopygium from side usually regularly rounded ---------- 2
2. Head with a pale yellowish stripe along venter which is of about equal width on its entire length, filling the interocular space, and without a dark spot on each side behind eye; upper margin of hypopygium with a squarish backwardly curved process which is more or less emarginate at tip (fig. 158), no erect spine within the upper border of hypopygium ---------- 3

Head with a pale yellowish stripe along venter which is narrower than interocular space or has a distinct dark spot on each side behind eye; upper margin of hypopygium not produced backward at apex, with a long spine within upper border (figs. 151, 152)____________________ 5

3. Fore coxa about twice as long as fore tibia______________________ 4

Fore coxa less than 1.5 as long as fore tibia_______**banksii** (Baker) (p. 87).

4. Mid and hind femora each with more than one brown band; seventh tergite obtusely rounded, projecting little if any beyond hypopygium (fig. 157).
**annulipes** (Stal) (p. 88).

Mid and hind femora each with only one brown band; seventh tergite more acutely rounded and projecting more or less beyond hypopygium.
**fraternus** (Say) (p. 89).

5. Apical spine of hypopygium conspicuously backwardly curved at tip (fig. 150); general color fuscous; surface rugulae of abdomen both above and below forming a distinct reticulation__________**uhleri** (Banks) (p. 86).

Apical hypopygial spine straight or almost so, only slightly curved at tip (fig. 153); general color stramineous; surface rugulae of abdomen chiefly longitudinal, not forming a reticulation________**neglectus**, new species (p. 87).

*Females.*

1. Basal postero-ventral spine on fore femur less than its own length from base of femur; apical tergite entire_____________**aberrans**, new species (p. 86).

Basal postero-ventral spine on fore femur more than its own length from base of femur______________________________________________ 2

2. Head with a pale yellowish stripe on venter which is not decidedly narrower than interocular space nor with a dark spot on each side behind eye______________________________________________________ 3

Head with a pale yellow stripe on venter which is narrower than interocular space or has a dark spot on each side behind eye________________ 5

3. Fore coxa only about one third longer than fore tibia__**banksii** (Baker) (p. 87).

Fore coxa nearly or quite twice as long as fore tibia________________ 4

4. Mid and hind femora each with more than one brown band; spines on postero-ventral surface of fore femur less elongate, the process between bases of antenna less pronounced, wing pads in apterous forms less developed than in *fraternus;* notch in apex of apical tergite of an open type, its sides varying from concave to nearly straight________**annulipes** (Stal) (p. 88).

Mid and hind femora each with one brown band; spines on postero-ventral surface of fore femur more elongate, the process between bases of antennae more pronounced, the wing pads in apterous forms better developed than in *annulipes;* notch in apical tergite of a narrower type, its sides more or less convex, the apex of the notch more acute (fig. 162).
**fraternus** (Say) (p. 89).

5. Seventh tergite entire or barely emarginate at apex (fig. 148) general color of species fuscous______________________________**uhleri** (Banks) (p. 86).

Seventh tergite with a short and acute apical incision (fig. 154); general color stramineous______________________**neglectus**, new species (p. 87).

### SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Male hypopygium with an erect spine inside of hind margin.

Fore coxa but little longer than fore tibia; first spine of fore femur at less than its length from base of femur. **aberrans.**

Fore coxa 1.5 or more longer than fore tibia; first spine of fore femur at more than its own length from base. **uhleri.**
**neglectus.**

Male hypopygium with a squarish process on hind margin; first spine of fore femur at more than its length from base.

Fore coxa less than 1.5 times as long as fore tibia. **banksii.**

Fore coxa nearly twice as long as fore tibia. **annulipes.**
**fraternus.**

### METAPTERUS ABERRANS, new species.

A small, dark, robust species, wth characters of male hypopygium and female genital segments similar to those of *uhleri*. The head lacks the process between the bases of antennae and the labrum is but little protruded, in one specimen almost imperceptibly so. The pronotum has a very deep constriction near posterior margin and its hind margin has a short backwardly projecting process in middle. Wing pads small. Apical tergite in female as in *uhleri* but shorter; male hypopygium as seen from the side as in figure 147, the upper posterior margin with an erect spine.

Length, 7–8 mm.

*Holotype.*—Male, allotype, and one male paratype, Austin, Tex., January 3, 1901 (Bueno).

### METAPTERUS UHLERI (Banks).

*Barce uhleri* BANKS, N. Emesidae, 1909, p. 47 [Southern Pines, N. C.].

This species, *aberrans* and *neglectus*, agree with *linearis*, the genotype, in having an erect spine inside the hind border of male hypopygium, but like all the other American species known to us differs from *linearis* in that the male claspers are not abruptly bent apically and directed upward on each of the apical spine. *M. aberrans*, *uhleri*, and *neglectus* have another character also in common with *linearis*, namely that the pale streak on lower surface of head is narrower than interocular width or is interrupted by a dark spot behind each eye. The external genital characters of both sexes of *M. uhleri* are illustrated by figures 148 to 151, the fore leg by figure 146.

Length, 7–9 mm.

Data for specimens examined: Forest Hills, Mass., March 30, 1915, F. X. Williams; Truro, Mass., Sept. 4, 1904; North Attleboro, Mass., Oct. 3, 1920, C. A. Frost (Parshley); Hyannisport, Mass., Aug. 18, 1899, J. L. Zabriskie (Am. Mus.); New York (Cornell Univ.); Central Park, Long Island, N. Y., April 11, 1915, G. P. Englehardt (Bueno); Sea Cliff, Long Island, N. Y., N. Banks (Paratype, McAtee); Ithaca, N. Y., July 21, 1921, Aug. 22, 1892 (Cornell Univ.); White Plains, N. Y., Oct. 25, 1908 (Bueno); Cape May County, N. J., April 10, 11, 1911, Wm. T. Davis (Davis); Lakehurst, N. J., May 2, 1908, H. G. Barber; Vienna, Va., Aug., 1919,

H. G. Barber (Barber); Southern Pines, N. C., December, N. Banks (Paratypes, U.S.N.M.); also same locality, Feb., March, June, Sept., Dec., A. H. Manee (Davis Coll. Cornell Univ., Bueno, Drake, Barber, Parshley); South Dakota (Parshley); Oxbow, Saskatchewan, April 14, 21, 22, 1907, F. Knab (U.S.N.M.).

Rarely a female specimen of this species has a distinct notch in posterior margin of apical tergite. The color varies somewhat and the varietal name *brunnea* Banks[14] was applied to specimens with pale spots on the connexivum and pale irrorations on the venter; the color of the dorsum suggests bronzed leather. Type examined at the Museum of Comparative Zoology. The proportion of winged specimens in the whole material is small.

### METAPTERUS NEGLECTUS, new species.

A larger and much paler species than *uhleri*, the general color being yellowish brown. Male hypopygium similar to that of *uhleri*, differing in having the apical spine without a conspicuously recurved tip (fig. 152, 153). Female differing as stated in the key, the apical tergite as in figure 154.

Length, 11–12 mm.

*Holotype.*—Male, Lakehurst, N. J., May 13, 1917, under a pile of old bricks, W. T. Davis (Davis). Allotype, Winchester, Mass., L. L. Thaxter (U.S.N.M.). Paratypes: male, Lakehurst, N. J., March 30, 1907, H. G. Barber (Barber); White Plains, N. Y., one male, August 31, 1909; one male, March, 1919, under a stone; one male, April 4, 1909; one male, April 9, 1911; one female, April 30, 1911; Staten Island, N. Y., March 29, 1903 (Bueno).

*Allotype.*—Female, Cat. No. 26739, U.S.N.M.

### METAPTERUS BANKSII (Baker).

*Barce banksii* BAKER, C. F. California Emesidae, Pomona Coll. Journ. Ent. 2, No. 2, May, 1910, p. 227 [Claremont, Calif.].

Similar in color to *fraternus*, differing as stated in key. The fore tibia of male is about three-sevenths as long as fore femur while in the preceding two species it is but little over one-third as long. The male hypopygium is very much less keeled on apical half than in *fraternus* and has the small process at apex above larger, while from the rear view it is much less tapered below (fig. 155). Both sexes have the process between bases of antennae moderately well developed.

Length, 9–12 mm.

Data for specimens examined:

Palm Springs, Calif., February 17; California, no other data, Uhler Coll. (U.S.N.M.); San Mateo County, Calif. (Cornell Univ.); Pasadena, Calif., June 17, 1908 (Ball).

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[14] Emesidae, 1909, p. 47.

### METAPTERUS ANNULIPES (Stal).

*Barce annulipes* STAL, C. Berlin Ent. Zeitschr., vol. 10, 1866, p. 168 [Wisconsin].

*Emesodema simplicipes* SAY Ms., Uhler, P. R. Notices of the Hemiptera Heteroptera in the collection of the late T. W. Harris, M. D. Proc. Boston Soc. Nat. Hist., vol. 19, pp. 430–431, Nov. 1878 [Salem, Mass.]. The synonymy of this name with *annulipes* is by no means certain, and would not be adopted on the basis of the original description. The type specimen, however, is reported to agree with *annulipes*. Without this testimony we should be inclined to use the same *simplicipes* for the following species and to drop Say's name as unidentifiable.

A brownish fuscous species, varying considerably in intensity of color, the darker specimens having the annulations of the legs most distinct. The broad yellowish stripe on ventral surface of head is uniform in width throughout and not narrower than interocular space, a character *annulipes* has in common with *banksii* and *fraternus*.

The principal structural characters for distinguishing *annulipes* among this group of species are enumerated in the key and illustrated in figures 156, 157, 158, 159; the comparatively small size of the process between bases of antennae appears to be a reliable character, judging from our material, which is quite extensive. The fore tibia and tarsus are illustrated by figure 145.

Length, 10–11 mm.

Data for specimens examined: Monmouth, Me., Oct. 10, 1920, C. A. Frost; Jackson, N. H., Sept. 22, 1907, Bryant (Parshley); Contoocook, N. H., Aug. 23, 1923, E. W. Hall (Iowa State Coll.); Andover, Mass., Nov. 9, 1915, F. X. Williams; Sherborn, Mass., Oct. 17, 1920, C. A. Frost; North Attleboro, Mass., Oct. 3, 1920, C. A. Frost; Cold Spring Harbor, L. I., N. Y., July 30, Aug. 2, 1922, H. M. Parshley (Parshley); Cypress Hills, L. I., N. Y., May 18, 1909, Chas. J. Martin (Am. Mus.); Indian Lake, Sabael, N. Y., Aug. 15, 1921 (Barber); White Plains, N. Y., March 2, 1919, Aug. 31, 1908, Oct. 19, 1919, Nov. 21, 1914 (Bueno); N. Y., Scudder (U.S.N.M.); Paterson, N. J., July 25 (Am. Mus.); Roselle, N. J., Oct. 5, 1913, H. G. Barber (Barber.); Penn Station, Pa., June 6 (Cornell Univ.); Aug. 2, 1902. M. Wirtner (Bueno), Aug. 6, 1905, M. Wirtner (Cornell Univ., U.S.N.M.); Henson Creek, Prince Georges County, Md. (Cornell Univ.); Plummer Island, Md., July 5, 1911, July 17, 1914, July 20, 1911, Sept. 2, 10, 1916, E. A. Schwarz and H. S. Barber, July 22, 1915, Aug. 29, 1905, and 1912, H. S. Barber (U.S.N.M.); Glen Echo, Md., July 23, 1921, J. R. Malloch (Biol. Surv.); Great Falls, Va., Sept. 5, 1916, W. L. McAtee; Virginia near Plummer Island, Md., March 18, 1917, W. L. McAtee (McAtee), July 21, 1912, R. A. Cushman, Sept. 21, 1912, H. S. Barber, Fairfax County, Va., Aug. 16, 1911, H. S. Barber (U.S.N.M.); Glencarlyn, Va., Oct. 10 (Cornell Univ.); Vienna, Va., Aug. 9, 1916, H. G. Barber (Barber); Ridgeway, Ont., Aug. 6, 1887 (Iowa State Coll.); Columbus, Ohio, Oct. 14, 17, 1906 (Ball); Wis. (U.S.N.M.); Winnipeg, Manitoba (Ball); Ames, Iowa, Sept. 13, 1907 (Iowa State Coll.), Aug. 13, 1895 (Ball).

### METAPTERUS FRATERNUS (Say).

*Ploiaria fraterna* SAY, THOMAS, Descriptions of new species of Heteropterous Hemiptera of North America, 1831; Complete Writings, vol. 1, 1859, pp. 358–359 [New Orleans].

A fairly common species, closely related to the preceding, averaging larger, and with more southern and western distribution. All our specimens from Texas, Louisiana, and Mississippi, and one from Missouri are winged, the others including one from Missouri are furnished with minute wing pads only. In the winged forms the fore wings are brownish with upper surface irregularly granulose, the slight elevations or granules darker than the remainder of wing. Distinguishable from *annulipes* as stated in the key, and illustrated in figures 160 to 162.

Length, 12–13 mm.

Data for specimens examined: Cold Spring Harbor, L. I., N. Y., July 1902, H. G. Barber (Barber); White Plains, N. Y., August 31, 1909, September 4, 1911, September 13, 1919, October 10, 1909, October 23, 1921, November 7, 1909; Palisades, N. J., August 20 (Bueno); Woodbury, N. J., January 1, 1905 (Drake); Bay Ridge, Md., August 3, 1905 (Cornell Univ.); Plum Point, Md., August 10, 1913, W. L. McAtee (McAtee); Chesapeake Beach, Md., August 3, 1913, A. Wetmore (Biol. Survey), September 4, N. Banks, September 2, 1908 (Cornell Univ.); Cabin John Bridge, Md., August, 1907, W. Palmer; Plummer Island, Md., October 4, 1912, October 26, 1913, laid eggs (See figs. 163, 164), H. S. Barber; Jackson Island, Md., July 3, 1911; Offutt Island, Md., October 3, 1919, H. S. Barber (U.S.N.M.); Glen Echo, Md., October 15, 1892, O. Heidemann (Iowa State Coll.); Washington, D. C., October 7, 1885, November 5, 1881 (U.S.N.M.), July 10, Feb. 5, 1893, F. C. Pratt (Cornell Univ.); Great Falls, Va., September 5, 1916, October 4, 1916. W. L. McAtee (McAtee, Drake, Biol. Survey); Falls Church, Va., August 30, 1904, October 1, September 5, November 2, N. Banks (Cornell Univ.); Southern Pines, N. C., December (Parshley); Daytona, Fla., (Cornell Univ.); Ohio (Drake); Natchez, Miss., May 13, 22, 25, 1909, E. S. Tucker; Baton Rouge, La., June 1, 1893, H. S. Weed (U.S.N.M.); Falls City, Nebr., July 31, H. G. Barber (Barber); Lincoln, Nebr., July, at light (Iowa State Coll.); Wichita, Kansas; Missouri; Charleston, Md., October 28, 1915; Durant, Okla., June 2, 1905, F. C. Bishopp; Texas; Dallas, Tex., May 10, 1908, E. S. Tucker, November 27, 1906, R. A. Cushman; Columbus, Tex., June 16 (U.S.N.M.).

It is only by assumption that this species has been identified with that described by Say. The original description is very inadequate, and the few tangible characters mentioned in it do not apply well to the present species. It would be no injustice to drop Say's name, as unidentifiable.

### Genus GHILIANELLA Spinola.

*Ghilianella* SPINOLA, M. Di alcuni Generi d'Insetti Artroidignati nuovamente proposti dal Socio Attuale Signor Marchese Massimiliano Spinola nella sua Tavola Sinottica di questo Ordine. Memorie di Matematica e di Fisica della Societa Italiana delle Scienze residente in Modena, vol. 25, pt. 1, 1852, pp. 142–143. Monobasic: Genotype, *G. filiventris*, new species [Para].

The inclusion and brief definition of *Ghilianella* in the Tavola Sinottica (p. 85) of the same work, is responsible for citation of that reference as the original description of the genus. However, we prefer the reference here given where the genus and its genotype are described at length.

Characters of the genus besides those mentioned in the key to genera are: the presence between bases of antennae of a projection varying from a mere wart to a prominent porrect or decurved spine (fig. 165); head and thorax more or less granulate, the former with a profound constriction anterior of eyes; meso- and meta-thorax each tricarinate (or with a median carina and lateral rows of tubercles above) and usually unicarinate below; abdomen more or less carinate or keeled below; front tibia with a patch of short pale golden hairs on inner side apically and a tuft of longer ones at the apex inferiorly; mid and hind legs and antennae each longer than body. Color varies much according to age, usually the nymphs are pale and the color darkens steadily with age until the final stage is dark reddish brown or even blackish; in some species, however, the adults are pale; when the legs have pale markings they are almost invariably as follows: mid and hind femora with two postmedian bands and a subapical spot, and tibiae with a sub-basal spot; in the pale species, dark markings tend to appear at these same places; frontal and femoral spines mostly pale. The whole head and body of *Ghilianella* species are sparsely pale haired, the hair tending to aggregate in patches about base of frontal spine, juncture of head and pronotum, and on sides anteriorly of meso- and meta-thoraces.

The principal characters for separating the species are derived from the terminal segments of the abdomen and are rarely mentioned in previous descriptions. We have had little success therefore in identifying described species of which we have not seen specimens. Precise determination of these species depends upon examination of the types practically all of which are in Europe. We have fortunately been able through the kindness of Dr. E. Bergroth to examine the types of his species, aid which has been of the utmost value in the study of the present genus.

However, inability to inspect other type specimens can not be permitted to prevent a revision of the genus which proves to be richer in species than has previously been suspected. This latter fact in itself insures that few of our species will prove identical with the older ones, while the total to be discovered in neotropical regions can only be indicated by an estimate so large that it would be considered absurd by many entomologists.

### KEY TO THE SPECIES.

#### *Males.*

1. Mesothorax distinctly longer than prothorax; shape of abdomen various ---- 2
   Mesothorax little if any longer than prothorax; abdomen gradually widening from base ---- 20
2. Abdomen with an abrupt bulbous swelling behind middle (figs. 196, 201) ---- 3
   Abdomen without bulbous swelling (figs. 169, 210) ---- 14
3. Spine between antennae well developed, acute; head and prothorax usually distinctly granulose; claspers of hypopygium with upper and lower margins in most species without a rounded subapical notch above or below; metathorax usually much attenuated anteriorly ---- 4
   Spine between antennae not developed, a mere wart, blunt; head and prothorax but little granulose; claspers of hypopygium long, obtriangular with at least the upper margin notched ---- 13
4. Hypopygium with a large apical hook like process which has an emargination or concavity on each side of hook, not entirely filled by the claspers (figs. 193, 194, 200) ---- 12
   Hypopygium with a small apical process which is visible only under high magnification, the upper margin of hypopygium but little concave, the claspers entirely filling the space between the margin and the process (fig. 197) ---- 5
5. Fifth tergite bearing a pair of strongly divergent long conical horns, equal in length to entire bulbosity (fig. 205) ---- **mirabilis**, new species (p. 124).
   Fifth tergite without such horns ---- 6
6. Seventh tergite short, sixth entirely incorporated into the bulbosity which thus appears almost terminal (fig. 201) ---- 7
   Seventh tergite long, sixth not wholly incorporated into bulbosity which is distinctly subterminal ---- 8
7. Sixth tergite more than half as long as fifth, provided with a smaller elevation similar in shape to that of fifth (fig. 201).
   **filiventris** Spinola (p. 123).
   Sixth tergite less than half as long as fifth, without elevations.
   **atriclava** Bergroth (p. 123).
8. Widest part of bulbosity in fourth segment; top of abdomen with 2 distinct longitudinal lines of gray hairs ---- **globifera** Bergroth (p. 110).
   Widest part of bulbosity in fifth segment ---- 9
9. Fifth tergite lacking subangulate ridged elevations; sixth trisinuate posteriorly ---- **claviventris** Bergroth (p. 109).
   Fifth tergite with subangulate ridged elevations; sixth slightly convex posteriorly ---- 10

10. Elevation of fifth tergite distinctly inside lateral margins of disk.
**approximata**, new species (p. 117).
Elevations of fifth tergite on lateral margins of disk, the margins passing over as carinae ------------ 11

11. Elevations of fifth tergite at middle; clasper oblong, about a third as wide as long (fig. 197) ------------ **perigynium**, new species (p. 120).
Elevations of fifth tergite nearer posterior margin; clasper much narrower, terete ------------ **recondita**, new species (p. 119).

12. Seventh tergite with a longitudinal carina on apical half, tip of tergite projecting well beyond apex of hypopygium; apical central hook of latter relatively small, not much curved at base and not standing well clear of the sternite at base so that it is only visible as a hook under a moderate magnification (fig. 193) ------------ **globulata**, new species (p. 118).
**subglobulata**, new species (p. 121).
Seventh tergite without longitudinal carina, tip of tergite projecting little if any beyond apex of hypopygium; apical hook of latter much curved at base, standing well clear of the sternite so that it is usually visible as a hook to the unaided eye (fig. 200) ------------ **uncinata**, new species (p. 122).

13. Hypopygial claspers each with a deep excavation on upper margin before apex, the lower margin entire (fig. 199); fifth sternite with regular miscroscopic striae which run from base to apex and are slightly outwardly directed ------------ **strigata**, new species (p. 121).
Hypopygial claspers each with a deep rounded excavation on upper margin before apex, and a deep incision about opposite on lower margin (fig. 194); fifth sternite lacking regular striae, granular, the granulations being partially grouped in irregular transverse rows.
**patruela**, new species (p. 119).

14. Abdomen nearly as wide at hypopygium as at any point proximad of it ------------ 15
Abdomen notably widest at third or fourth segment; seventh tergite remarkably elongated and slender, projecting beyond apex of hypopygium by at least the length of latter (figs. 187, 188) ------------ 19

15. Hypopygium almost annular, the terminal hook large, flanked each side by a space which is not filled by the broadly triangular claspers; seventh tergite not especially narrowed subapically, apex a strong process projecting well beyond hypopygium (fig. 180) ------------ **apiculata**, new species (p. 111).
Hypopygium more elongate, hook small, concealed between apices of claspers; apex of seventh tergite not strongly tuberculate nor projecting far beyond hypopygium (fig. 181) ------------ 16

16. Hypopygium somewhat inflated, notably deeper vertically than adjacent part of abdomen ------------ 18
Hypopygium scarcely inflated and but little deeper than abdomen ------------ 17

17. Claspers oblong, almost truncate apically, slightly beveled off at inferior angle ------------ **ica**, new species (p. 111).
Claspers broader basally, rather pointed apically, superior angle sloped off with a long bevel (fig. 181) ------------ **pachitea**, new species (p. 111).

18. Seventh tergite longer, much narrowed and slightly transversely corrugated subapically, the apex pointed and slightly keeled.
**aracataca**, new species (p. 112).
Seventh tergite shorter, but little narrowed and faintly transversely wrinkled subapically, the apex triangular, bluntly pointed.
**colona**, new species (p. 112).

19. Abdomen widest at fourth segment, each tergite with a pair of small round spots of pale yellow pile on hind margin; spiracles yellow.
**assa-nutrix** Bergroth (p. 114).

Abdomen widest at fifth segment, tergites lacking pilose spots; spiracles blackish ---------------------------- **gladiator**, new species (p. 115).

20. Hind margin of sixth sternite almost straight; head and thorax copiously, coarsely granulate; seventh tergite triangular apically, not keeled, extending little if any beyond hypopygium (fig. 175); apical antennal segment only a little longer than subapical ------- **pascoei** Bergroth (p. 106).

Hind margin of sixth sternite with a broad central rounded concavity and smaller lateral ones, the sternite longest at a point between the lateral margin and median line ------------------------------------------ 21

21. Head and thorax conspicuously granulate; length 15 to 17 mm. **minimula**, new species (p. 105).

Head and thorax not conspicuously granulate; longer species -------- 22

22. Eighth sternite visible on its entire width, the spiracle moderately pedunculate ---------------------------------------------------- 23

Eighth sternite with the sides more or less concealed --------------- 27

23. Abdomen nearly cylindrical; clasper very broadly triangular, width at apex equaling length (fig. 177) --------------- **personata**, new species (p. 108).

Abdomen otherwise; clasper not so broadly triangular ---------------- 24

24. Abdomen clavate, posterior angles of tergites subangularly ampliate; tergites lacking dark warts on middle of hind margins. **angulata** (Uhler) (p. 128).

Abdomen parallel-sided; tergites 2–6 each with a small dark wart at middle of hind margin ----------------------------------------- 25

25. Narrowed portion of seventh tergite distinctly longer than terminal expanded part (fig. 170) ----------------- **persimilis**, new species (p. 103).

Narrowed portion of seventh tergite distinctly shorter than terminal expanded part ------------------------------------------------ 26

26. Claspers of about same width throughout their length; pale species. **productilis** Barber (p. 102).

Claspers wide subbasally, much narrowed apically; dark species. **simillima**, new species (p. 102).

27. Eighth sternite visible only at center, its sides, including spiracles, covered; abdomen with flecks of denser pubescence; fore femur gradually thickened from base to first ventral spine ----------- **maculata**, new species (p. 108).

Spiracles of eighth sternite exposed; head, thorax and abdomen with patches of dense golden pubescence; fore femur thickened on basal half of that part basad of the first ventral spine (fig. 215). **insidiatrix** Bergroth (p. 126).

### KEY TO THE SPECIES.

#### *Females.*

1. Mesothorax (viewed from above) longer than prothorax ------------- 2

Mesothorax not longer than prothorax ---------------------------- 17

2. Abdomen with a bulbous swelling beyond middle, and prominent lateral elevations on either fifth or sixth tergites (figs. 196, 201) ---------- 3

Abdomen without bulbous swelling or lateral elevations on fifth and sixth tergites ------------------------------------------------ 12

3. Fifth tergite the widest, its sides before hind margin prominently elevated, usually standing above connexivum ----------------------- 4

Sixth tergite about as wide as or wider than fifth, bearing a large median tubercle (fig. 184) ------------------------------------------ 15

4. Sixth tergite lacking a large median tubercle, though fifth and sixth tergites may be more or less elevated at middle of hind margin________ 5
Sixth tergite with a prominent, median, falcate tubercle on its hind margin.
**bethei** (Dohrn) (p. 112).

5. Fifth tergite with a pair of divergent, long conical horns, each nearly equal in length to width of tergite (fig. 208)____**mirabilis**, new species (p. 124).
Fifth tergite without such horns________________________________________ 6

6. Elevations of fifth tergite distinctly inside lateral margins of disk.
**approximata**, new species (p. 117).
Elevations of fifth tergite on lateral margins of disk, the margins passing over them as carinae__________________________________________ 7

7. Pronotum not noticeably granulose; abdomen with one or more pairs of large pale pilose spots on dorsum and venter__**signata**, new species (p. 120).
Pronotum distinctly granulose; abdomen not or very inconspicuously spotted ______________________________________________________ 8

8. Eighth tergite as long as wide_______________________________________ 10
Eighth tergite much shorter than wide_____________________________ 9

9. Posterior lateral angles of seventh tergite produced no farther posteriorly than median convexity of hind margin which is more or less tuberculate.
**globulata**, new species (p. 118).
Posterior angles of seventh tergite produced distinctly beyond middle of hind margin, which is merely convex, not at all tuberculate.
**subglobulata**, new species (p. 121).

10. Posterior lateral angles of seventh tergite produced distinctly beyond middle of hind margin which is not tuberculate___**gladiator**, new species (p. 115).
Posterior lateral angles of sixth tergite produced no farther than median convexity of hind margin which is slightly tuberculate_____________ 11

11. Seventh sternite about twice as long on median line as sixth, with a broad convex process apically which is slightly emarginate medianly.
**perigynium**, new species (p. 120).
Seventh sternite only a third longer than sixth; somewhat angulate apically.
**recondita**, new species (p. 119).

12. Seventh tergite with the posterior angles produced as divergent, acute processes; other tergites ornamented on their hind margins with a pair of spots of golden pubescence; abdomen boat-shaped__**assa-nutrix** Bergroth (p. 114).
Posterior angles of seventh tergite not so produced; abdomen clavate, not so ornamented__________________________________________________ 13

13. Tergite 7 about as wide as long, with a distinct median tubercle posteriorly; sternite 7 merely convex medianly, but little produced.
**filiventris** Spinola (p. 123).
Tergite 7 not tuberculate; sternite 7 much produced and acute posteriorly______________________________________________________ 14

14. Tergite 7 much longer than wide, middle of hind margin conspicuously declivate, the lateral angles prominent, acute; sternites 5 to 7 as in figure 191__________________________________**stipitata**, new species (p. 116).
Tergite 7 little longer than wide, hind margin not declivate medianly, almost straight across, the lateral angles and median point only very slightly emphasized; sternites 5 to 7 as in figure 192__**similata**, new species (p. 116).

15. Fifth tergite about equal in length to its width at hind margin; abdomen with a bulbous swelling beyond middle____**pendula**, new species (p. 116).
Fifth tergite about twice as long as its width at hind margin; abdomen tapered from base to apex, or slightly clubbed apically_______________ 16

16. Seventh sternite very slightly longer than sixth, the latter with the hind margin slightly concave ---------- **cuneata**, new species (p. 113).

Seventh sternite at least 1.5 as long as sixth on median line, the latter with a very deep concavity on hind margin ---------- **aracataca**, new species (p. 112).

17. Posterior angles of tergites more or less ampliate or produced, the outline of dorsum of abdomen as seen from above not a continuous straight or curved line (fig. 210) ---------- 18

Posterior angles of tergites (except sometimes the seventh) not produced, the outline or dorsum of abdomen a continuous straight (fig. 169) or curved line ---------- 23

18. Fore femur notably thicker near base than at first strong spine (fig. 213) ---------- 19

Fore femur enlarging gradually from base to first strong spine (fig. 185) ---------- 21

19. A strong tubercle on hind margin of sixth tergite (fig. 184) ---------- 20

No obvious tubercle on hind margin of sixth tergite. **glabrata**, new species (p. 128).

20. Eighth tergite with disk prominently elevated each side of a broad median sulcus; ninth tergite convex medianly the margin slightly elevated; corrugations of these tergites indistinct ---------- **insidiatrix** Bergroth (p. 126).

Eighth and ninth tergites with disk depressed and margins elevated, each longitudinally carinate and transversely corrugated. **amicula**, new species (p. 127).

21. Angulations of tergites more pronounced; apex of sixth notably wider than that of seventh (fig. 210) ---------- 22

Angulation of tergites less pronounced; apex of sixth tergite scarcely wider than that of seventh ---------- **peruviana**, new species (p. 125).

22. Elevated margins of ninth tergite produced apically as distinct spines (fig. 211) ---------- **annectens**, new species (p. 125).

Elevated margins of ninth tergite not forming spines (fig. 213). **truncata**, new species (p. 126).

23. Basal spine of fore femur at less than its own length from base of femur (i. e. juncture of the trochanter); fore tibia and tarsus combined three-fourths as long as femur (fig. 167); spine between bases of antennae much reduced, a mere wart ---------- **galapagensis** Heidemann (p. 100).

Basal spine of fore femur at distinctly more than its own length from base of femur; other characters not as above ---------- 24

24. Seventh sternite distinctly produced on middle of hind margin ---------- 25

Seventh sternite not produced ---------- 31

25. Hind margin of seventh tergite without tubercle ---------- 26

Hind margin of seventh tergite more or less tuberculate ---------- 28

26. Hind margin of seventh tergite concave medianly. **personata**, new species (p. 108).

Hind margin of seventh tergite not concave medianly ---------- 27

27. Hind margin of seventh tergite straight across ---------- **semipallida** Bergroth (p. 100).

Hind margin of seventh tergite angulate, produced medianly but not tuberculate ---------- **alterata**, new species (p. 107).

28. Median tubercle on hind margin of seventh tergite extending farther posteriorly than lateral angles; ninth tergite with 3 finger-like ridges at apex. (fig. 172) ---------- **persimilis**, new species (p. 103).

Median tubercle on hind margin of seventh tergite not extending as far posteriorly as laterial angles; apex of ninth tergite lacking finger-like longitudinal ridges ---------- 29

29. Apex of ninth tergite distinctly upcurved, transversely wrinkled and with a low median longitudinal carina; process of seventh sternite large.
**productilis** Barber (p. 102).
Apex of ninth tergite otherwise; process of seventh sternite small---- 30
30. Apex of ninth tergite distinctly decurved, longitudinally strigate, and with a strong median carina, the lateral margins depressed.
**succincta,** new species (p. 105).
Apex of ninth tergite slightly decurved, the lateral margins strongly elevated, depressed median area with a carina which extends from the upper transversely corrugated third of the sternite.
**aliena,** new species (p. 106).
31. Eighth tergite visible only as two small rounded laterally situated protuberances, below apex of seventh tergite, not continued downward in center over base of ninth tergite (fig. 174)---------**alveola,** new species (p. 104).
Eighth tergite covering base of ninth tergite---------------------- 32
32. Sixth tergite with a prominent protuberance, seventh with a smaller one on middle of hind margin (fig. 178)------------------------------- 33
Sixth tergite without a prominent protuberance-------------------- 34
33. Abdomen ten times as long as its greatest width; first antennal joint with several dark bands-----------------------------**varicornis** Dohrn (p. 101).
Abdomen not so long and slender, clavate; ninth tergite rounded apically, the depressed apex overlaid by two short tapering ridges (fig. 179).
**perversa,** new species (p. 110).
34. Hind margin of sixth sternite almost straight; apex of ninth tergite with a strong bidentate tubercle on each side--**bicaudata,** new species (p. 101).
Hind margin of sixth sternite more or less concave------------------- 35
35. Sixth sternite a third longer on sides than in middle (fig. 176).
**pascoei** Bergroth (p. 106).
Sixth sternite not so deeply emarginate posteriorly------------------ 36
36. Apex of ninth tergite overlaid by two strong finger-like processes (fig. 173); length over 30 mm-------------------------**longula,** new species (p. 104).
Apex of ninth tergite with a low median carina; length less than 20 mm.
**minimula,** new species (p. 105).

REMARKS ON PREVIOUSLY DESCRIBED SPECIES OTHER THAN THOSE INCLUDED IN THE KEY.

*analis* (*Emesa*) DOHRN. Emesina, 1860, pp. 229–230, pl. 1, fig. 5 [Surinam].

This species runs to the division of our key including *apiculata* and *aracataca.* Dohrn's figure shows that the hypopygium is not annular with a large hook as in the former, and that the sixth tergite projects far beyond hypopygium which is not true of the latter.

*annulata* (*Emesa*) DOHRN. Nachträge, 1863, pp. 65–6 [S. A.?].

Closely related to *analis*, "last dorsal segment scarcely petiolate." This indicates that the species is to be compared with *aracataca* and may possibly be identical.

*argentina* BERG, CAROL. Tres Reduviidae novae argentinae. Communicaciones del Museo Nacional de Buenos Aires, vol. 1, No. 6, May 23, 1900, pp. 189–190 [prope Buenos Aires].

Not a *Ghilianella*, possibly a Ploiaria but the characters given do not permit its being run in our key to that genus.

*brasiliensis* (*Emesa*) DOHRN. Emesina, 1860, pp. 227–8 [Brazil].

Abdomen with high and sharp lateral carinae, mid and hind femora each with 2 yellowish rings.

*bulbifera* CHAMPION. Biologia, vol. 2, 1898, p. 171, pl. 10, figs. 17–18 [Panama].

The male runs to *recondita* among our species, but has the sixth segment less involved in the bulbosity and the seventh tergite not surpassing hypopygium and apparently not apiculate. The female described by Champion probably is a different species; specimens seemingly agreeing with Champion's description of that sex are given a new name on page 116.

*gerstaeckeri* (*Emesa*) DOHRN. Emesina, 1860, pp. 223–4 [Haiti].

There is very little doubt that all of the American species in section B or Dohrn's key to Emesa, are *Ghilianella*. The present species is said to have the sixth (that is seventh) segment bispinose apically.

*gibbiventris* CHAMPION. Biologia, vol. 2, 1898, p. 172, pl. 10, fig. 20 [Panama].

This species is of a different type from any we have seen, since while the pro- and meso-thorax are subequal in length, the abdomen in the male is bulbous.

*Granulata* CHAMPION. Biologia, vol. 2, 1898, pp. 171–2, pl. 10, fig. 19 [British Honduras].

Unidentifiable, the terminal abdominal segments of the type being missing.

*ignorata* DOHRN. Emesina, 1860, pp. 238–9, pl. 1, figs. 9, 11 [La Guayra, and Brazil].

The male runs to *recondita* in our key but does not have the seventh tergite produced beyond hypopygium. Champion[15] describes and illustrates a species under Dohrn's name, but he defines the species on characters not mentioned by Dohrn, and does not speak of seeing the type; hence there is no certainty that the identification is correct.

*imbecilla* (*Emesa*) DOHRN. Emesina, 1860, pp. 228–9 [Para].

Mid and hind femora each with three pale rings; described from a specimen with collapsed abdomen; may not be identifiable.

*signoreti* (*Emesa*) DOHRN. Emesina, 1860, p. 227, pl. 1, fig. 1 [Jamaica].

This species has the mid and hind femora each with apex and two subapical rings paler, not agreeing in this respect with any species having the same shaped abdomen (figured) that we have examined.

*spinolae* DOHRN. Emesina, 1860, p. 238 [Amazon River].

Abdominal segments 1–3 yellow and longer even than in *filiventris* indicates a species distinct from any here described.

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[15] Biologia, vol. 2, pp. 170–1, pl. 10, figs. 15–16, 1898.

## SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Claws of fore tarsus two, the inner short, closely applied to the base of outer. (Subgenus *Ghilianella* Spinola.)

Inner row of armature of fore femur consisting of hairs or bristles which may or may not arise from wart-like bases (fig. 186), usually a single spine at apical end of the series; fore femur usually slender. enlarging slightly from base toward first stout spine (fig. 185).

Fore femur rather stout, first strong spine at less than its own length from base (that is apex of trochanter); abdomen racket-shaped.
**galapagensis.**

Fore femur usually more slender, first strong spine at more (usually considerably more) than its own length from base.

A small wart (dark in mature specimens) at middle of hind margin of each of tergites 2–6; spiracles dark, prominent; a dark blotch or spot on inner side of upper surface of fore femur near apex.

Metathorax shorter than mesothorax; unspined portion of fore femur shorter than spined part **semipallida.**
**varicornis.**
**bicaudata.**

Metathorax nearly or quite as long as mesothorax; unspined portion of fore femur nearly equal in length to spined part.
**simillima.**
**productilis.**
**persimilis.**
**longula.**

No such warts on tergites 2–6; species lacking the above combination of characters.

Mesothorax not longer than prothorax; abdomen not bulbous.

Prothorax longer; spineless part of fore femur shorter than spined portion **alveola.**
**minimula.**
**succincta.**

Mesothorax and prothorax about equal in length.

Spineless part of fore femur distinctly shorter than spined portion.
**aliena.**
**pascoei.**
**alterata.**

Spineless part of fore femur nearly as long as spined portion.
**maculata.**
**personata.**

Mesothorax distinctly longer than prothorax; abdomen bulbous.
**claviventris.**
**globifera.**[16]

Inner row of armature of fore femur consisting of spines (which may alternate large and small or be almost equal in size) and between them longer fine hairs (fig. 204).

Fore femur slender in most cases, with the unspined portion relatively long; abdominal tergites not angulate produced.

Mesothorax shorter than prothorax; abdomen nearly parallel-sided **perversa.**

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[16] See footnote 17, p. 99.

Mesothorax longer than prothorax.
Abdomen long, nearly parallel-sided------------------**apiculata.**[17]
**ica.**
Abdomen clavate----------------------------**pachitea.**
**colona.**
**bethei.**
**aracataca.**
**cuneata.**
**assa-nutrix.**
[**filiventris,** female].
**gladiator,** male.
**stipitata.**
**similata.**
Abdomen bulbous.
Bulbosity longer than wide-------------**gladiator,** female.
**pendula.**
Bulbosity as wide as or wider than long.
Bulbosity subterminal---------------**approximata.**
**globifera.**[18]
**globulata.**
**patruela.**
**perigynium.**
**recondita.**
**signata.**
**strigata.**
**subglobulata.**
**uncinata.**
Bulbosity terminal------------------**atriclava.**
**filiventris,** male.
**mirabilis.**

Fore femur stouter, the unspined portion relatively short, but little longer than basal spine; abdominal tergites angulate produced at sides posteriorly; prothorax longest, mesothorax and metathorax successively shorter-------------------------**peruviana.**
**truncata.**
**annectens.**

Claw of fore tarsus single; inner row of armature of fore femur consisting of chitinous tubercles or spines, with a few long hairs intermixed (fig. 212); a strong spine on outer side slightly distad of basal spine, out of alignment with the others and slightly outwardly directed; posterior angles of abdominal tergites slightly ampliate.

Claw separated from tarsus by a suture; fore femur rather slender as a whole, but notably thicker near base than at first strong spine (fig. 215) (Subgenus *Ploeodonyx* new subgenus, type species *Ghilianella insidiatrix* Bergroth).
**insidiatrix.**
**amicula.**
**glabrata.**

Claw entirely fused with tarsus; fore femur rather stout, little if any thicker at base than at first strong spine; hind margin of prothorax with two rather long, blunt, divergent teat-like processes. (Subgenus *Lissonyx*, new subgenus, type species *Emesa angulata* Uhler.)
**angulata.**

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[17] Armature of fore femur unknown.

[18] Armature of fore femur unknown, the species entered in two places in the list.

## DESCRIPTIONS OF THE SPECIES.

### GHILIANELLA GALAPAGENSIS Heidemann.

*Ghilianella galapagensis* HEIDEMANN, O. H. Papers from the Hopkins Stanford Galapagos Expedition, 1898–1899. Entomological Results (1) Hemiptera, Proc. Washington Acad. Sci., vol. 3, pp. 367–8, Aug. 23, 1901 [Hood Island].

*Female.*—General color testaceous, the abdomen considerably clouded with fuscous; abdomen gradually widened to juncture of fifth and sixth segments and tapered from thence to apex, the expansion involving more segments (3–7) and having more of them (4–7) of nearly equal width than in other species; dorsal sutures transverse, the tergites with small but progressively increasing elevations on the hind margins of 2–6; posterior angles of tergite 7 rather prominent, the hind margin between nearly straight, with a median elevation; eighth tergite two-thirds as long as broad, very slightly sculptured, apex very broadly rounded; exposed portion of tergite 9 much shorter than 8, depressed apically on each side of a short keel; hind margins of sternites 4–5 nearly transverse, slightly inclined anteriorly, of 2, 3, and 6, more or less emarginate medianly and arcuate laterally, 6 most so; seventh tergite convex medianly, concave laterally, eighth just the reverse, with a large median emargination, seventh with a small one. Fore leg and its armature as in figures 167, 168.

Length, 12.5 mm.

*Holotype.*—Female, Hood Island, Galapagos Archipelago, May 18, 1899 (type No. 4931, U.S.N.M.).

A nymph also, Albemarle Island, March 11, 1899 (U.S.N.M.).

### GHILIANELLA SEMIPALLIDA Bergroth.

*Ghilianella semipallida* BERGROTH, E. Ploeariinen 1906, pp. 317–318 [Venezuela].

*Female.*—A specimen without antennae, or mid and hind legs, and with the abdomen collapsed, Corozal, Collection E. Bergroth, is the only one we have seen. General color of upper surface stramineous, of lower pale castaneous. Frontal spine porrect, sharp. Head sparsely granulate, divisions of thorax with practically no granulations on top and only a few along the sides; mesothorax longer than either of the other divisions. Abdomen very long and slender, apparently widening gradually from base to apex; tergites without tubercles; hind margin of seventh about straight across; eighth semicircular; ninth longer, cuneate portion of disk raised above lateral portions, its point coalescing at apex with the slightly elevated margins. Seventh sternite slightly angulate medianly, slightly concave laterally; eighth sternite broadly exposed on each side.

Length, 23 mm.

Corozal, Venezuela (Coll. E. Bergroth). The type.

### GHILIANELLA VARICORNIS (Dohrn).

*E.[mesa] varicornis* DOHRN, A. Emesina, 1860, pp. 226–227 [Porto Rico].
*Ghilianella variicornis* BERGROTH, E. Ploeariinen 1906, p. 317.

Dohrn had a male with collapsed abdomen and his description deals mainly with coloration; Bergroth describes the structural characters from a female, the specimen examined during the present revision.

*Female.*—Closely related to *G. productilis* Barber, of the same long slender form, and coloration including the characteristic dark dots; those on posterior lobe of head and on pronotum are obsolete, however, in the specimen at hand, while there is a faint pair on front lobe of head. Legs stramineous, mid and hind pairs variegated, the mid tibiae each with a single distinct, and the femora with numerous indistinct, fuscous annuli; some longitudinal striping each side of the knee-joint. Basal segment of antenna with numerous faint brown annuli. Frontal spine prominent, decurved; head and thorax moderately granulate; the divisions of thorax decreasing in length from front to rear; a tubercle each side of base of head on anterior margin of pronotum, prominent, rather pointed, much more distinct than in *G. productilis.* Abdomen widening very gradually from base to apex, tubercled as in *G. productilis*, the lateral angles and median tubercle of 7 about equally produced; eighth semi-octagonal in shape, transversely wrinkled and indistinctly longitudinally keeled, the apex rather pointed, and the margins between apex and lateral angles slightly concave; ninth longer than eighth, faintly transversely corrugated, slightly narrowed apically, apex concave, with the lateral angles each side of the concavity distinctly pointed as seen from behind, broader as seen from side. Seventh sternite distinctly concave medianly, the sides of hind margin also shallowly concave.

Length, 26.5 mm.

Porto Rico (Coll. E. Bergroth).

### GHILIANELLA BICAUDATA, new species.

*Female.*—Testaceous, legs and thorax above washed with rufous and lightly marked, the thorax below and abdomen above more heavily, variegated, with fuscous; a pair of dark blotches near hind margin of each sternite; species in general appearance much like *productilis.* Abdomen widening gradually to juncture of fourth and fifth segments, then tapering very slightly to end; connexivum slightly elevated; central strips of tergites with a longitudinal ridge; seventh tergite with the lateral angles slightly flaring and projecting well posteriorly, the hind margin between them nearly straight and bearing at the middle a terete, pointed, porrect tubercle, which slightly exceeds the lateral angles (fig. 169); eighth tergite more than twice as wide as long, strongly transversely corrugated, apical margin wide, erose; ninth tergite longer than eighth, transversely wrinkled, narrowed apically, the posterior angles raised into two strong bidentate tubercles; hind margins of sternites 2–6 slightly concave; seventh somewhat convex medianly and concave laterally; eighth narrowly visible on each side.

Length, 24 mm.

*Holotype.*—Female, Cayamas, Cuba, Jan. 24, E. A. Schwarz (U.S.N.M.).

*Type.*—Female, Cat. No. 26740, U.S.N.M.

### GHILIANELLA SIMILLIMA, new species.

A species closely allied to *productilis*, agreeing with it even in shape of seventh tergite (in contrast to *persimilis*), but in the single male specimen at hand, dark castaneous so that the characteristic dark dots of this group of species are much obscured. However, they are discernible upon close inspection. Legs and antennae paler castaneous than body but without pale annuli. Hypopygium rather short, opening upward, the sides rather pinched in, the upper margin flaring laterally and ridged posteriorly, claspers as described in key.

Length, 29 mm.

*Holotype.*—Male labelled "Cuba, Sojo, 6 Al. 83" (Paris Mus.).

### GHILIANELLA PRODUCTILIS Barber.

*Ghilianella productilis* BARBER, H. G. Insects of Florida, vol. 2, Hemiptera, Bull. Amer. Mus. Nat. Hist., vol. 33, pp. 502–3, Aug. 21, 1914. [Marco, Fla.]

*Male.*—General color light reddish-brown, more or less variegated with fuscous; the legs and antennae stramineous, punctate but not annulate with the general color. There is a distinct black dot on the upper surface of each fore femur near the apex, a pair of dots about middle of posterior lobe of head, and another pair sometimes larger than the preceding about middle of pronotum; each abdominal sternite from 3–6, also bears near its hind margin a pair of black dots which tend to become larger and blotch-like posteriorly. Pilosity fine, short, pale, more abundant toward apices of mid and hind legs and antennae. Abdomen almost parallel-sided, widest at hypopygium, a black wart on middle of hind margin of tergites 2–6, the connexivum more or less elevated, the spiracles dark. Seventh tergite somewhat longer than sixth, a little constricted beyond middle, the apical moiety faintly transversely corrugated, lanceolate in outline, with a rounded keel apically, and projecting a little beyond hypopygium. Posterior margins of sternites 2–6, more or less emarginate medianly, and arcuate laterally, most pronounced on 6; 7 a little emarginate, 8 a little convex medianly, both slightly concave laterally; claspers oblong.

*Female.*—Color as in male; form of abdomen much the same, seventh tergite about one-third shorter than sixth, the lateral angles produced distinctly beyond the keeled and slightly tuberculate middle of hind margin; eighth tergite about semicircular, keeled longitudinally and corrugated transversely; ninth somewhat longer than eighth, keeled, corrugated herringbone fashion, narrowed, rounded, and upturned apically; sutures between sternites less sinuate than in male; seventh sternite somewhat shorter than sixth, its hind margin concave laterally and forming a distinct rounded process medianly; eighth sternite appearing as an elliptical plate on each side, spiracle barely visible.

Length, 23–25 mm.

*Holotype.*—Male, Marco, Fla., April 19, 1912, Wm. T. Davis (Coll. Davis); males, females, and nymphs from Big Pine, Fla., March 8, 1919, H. S. Barber; and Vict. de las Tunas, Cuba, W. M. Mann (U.S.N.M.).

In the male nymph the eighth tergite is broadly visible across base of anal tube, the ninth apparently is membraneous, the seventh has a large upwardly and backwardly projecting pointed process, and the lateral angles slightly pointed tuberculate; in the female nymph the seventh tergite has a rather prominent erect tubercle, the eighth and ninth are keeled and less rounded apically than in adult since they form the roof of complete segments inclosing the anal tube.

### GHILIANELLA PERSIMILIS, new species.

*Male.*—Very similar to male of *productilis;* the only tangible difference seems to be that in this species the narrowed portion of the seventh tergite is distinctly longer than the terminal expanded, then apiculate part (fig. 170), while in *productilis* it is distinctly shorter. Hypopygium of male as in figure 171.

*Female.*—Color much as in male; very similar to female of *productilis*, the chief distinction, being in the form of tergites 7–9 and sternite 7; these have been mentioned in the key, to the descriptions in which may be added that the eighth tergite is much broader than long, transversely wrinkled, and very obtusely angulate at apex; tergite 9 is somewhat wrinkled above and much narrowed apically; hind margin of sternite 7 is only slightly convex medianly and concave laterally (fig. 172).

Length, 21–23 mm.

*Holotype.*—Male, allotype female, Vict. de las Tunas, Cuba, W. M. Mann. (U.S.N.M.)

*Type and allotype.*—Male, Cat. No. 26741, U.S.N.M.

A female nymph with same data has the lateral angles of seventh tergite less prominent, the median tubercle long, and elevated at an angle of 45°; eighth and ninth tergites indistinctly keeled and transversely wrinkled. Another female nymph, apparently of this species has the data: Havana, Cuba, 1908, P. Serre (Paris Mus.).

### GHILIANELLA LONGULA, new species.

*Female.*—Color dark reddish brown, legs paler, femoral and frontal spines whitish; head and thorax only slightly granulate; hairs throughout abundant, short grayish to yellowish; abdomen attaining nearly its full width at third segment, widening almost imperceptibly caudad, except at end of seventh tergite, the posterior angles of which are flaring and moderately angulate-produced; hind margin of this tergite between the produced angles nearly straight, bearing medianly a porrect tubercle considerably shorter than the lateral productions; eighth tergite broad, much wrinkled, the processes much elevated, free and pointed apically (fig. 173); hind margins of sternites 2–6, moderately emarginate medianly, and slightly sinuate laterally; seventh sternite convex medianly, concave laterally.

Length, 32 mm.

*Holotype.*—Female, San Blas, Pinar del Rio, Cuba, 1918, W. M. Mann (U.S.N.M.).

*Type.*—Female, Cat. No. 26742, U.S.N.M.

### GHILIANELLA ALVEOLA, new species.

*Female.*—Legs stramineous tinged with reddish; head and thorax testaceous, darker below, conspicuously granulate; abdomen testaceous, marbled with fuscous, lightly above and heavily below; abdomen widening gradually to apex of seventh tergite, lateral strips of tergites and the connexivum coelevated, vertical except at extreme apex; sutures between tergites transverse, each tergite with an indistinct longitudinal ridge, darker colored posteriorly; seventh tergite roughened on disk, expanded apically, the posterior angles prominent, rounded, the margin between them convex, bearing at the middle a short pointed tubercle; eighth tergite as described in key; ninth transversely corrugated, and broadly longitudinally sulcate from base to near apex where elevations each side of the sulcus are interrupted, apical margin elevated, calloused (fig. 174); hind margin of sixth sternite decidedly sinuate laterally, the preceding sternites with only a suggestion of this form; hind margin of seventh sternite very broadly and shallowly emarginate; eighth sternite visible as an elliptical plate on each side.

Length, 20 mm.

*Holotype.*—Female, Balthazar, Grenada, H. H. Smith (U.S.N.M.).

*Type.*—Female, Cat. No. 26743, U.S.N.M.

### GHILIANELLA MINIMULA, new species.

*Male.*—Head and body dark reddish-brown, legs and antennae yellowish, fuscous near joints; head and thorax decidedly granulate, pubescence short and sparse. Frontal spine strong, porrect, head with a pair of divergent pointed tubercles just behind transverse sulcus. Abdomen widest at the anterior part of fifth segment, tapering gradually both fore and aft; seventh tergite narrowing rather rapidly from middle to the rather broadly rounded apex which projects a little beyond hypopygium. Hind margins of all sternites emarginate medianly, those of 5 and 6 most so, that of 7 very broadly and shallowly, and that of 8, narrowly and slightly. Hypopygium short, opening upward, claspers short, tapering from base to apex.

*Female.*—Color, granulation and pubescence, also spine and tubercles of head as in male. Abdomen widening to end of seventh tergite, which has a moderate median tubercle a little farther produced than the hind angles. Eighth tergite short, semi-elliptical, ninth moderately long, rounded at apex, each with a median carina and transverse corrugations. Sutures between sternites on the same plan as in male, hind margin of seventh prominent but not produced medianly, concave laterally; eighth visible only on sides.

Length, 15–17 mm.

*Holotype.*—Male, paratype female, allotype, female, Chapada, Brazil, September, no date, and August, respectively (Carnegie Mus.).

### GHILIANELLA SUCCINCTA, new species.

While this species runs in our key to the same couplet with *G. productilis*, it is not as closely related to that species as is *persimilis*, lacking the long terete head and characteristic dark dots, in addition to having a distinctively shaped abdomen.

*Female.*—Fuscous, spotted and marbled with ochraceous; head and thorax indistinctly granulate, but with plentiful, short, crinkly, pale reddish hair, abdomen more sparsely provided with similar but straight hairs; the seventh tergite is but little longer than wide (in *productilis* it is twice as long as wide); lateral pieces of this tergite produced posteriorly as short rounded angles, the hind margin between them slightly convex but not tuberculate medianly; eighth tergite semi-elliptical, with broad median carina and transverse corrugations; ninth as described in key. Hind margin of sixth sternite slightly emarginate medianly and less so laterally, of seventh rather strongly concave, with a short triangular process in the middle.

Length, 23 mm.

*Holotype.*—Female, Para, Brazil (Carnegie Mus.).

### GHILIANELLA ALIENA, new species.

*Female.*—Legs and antennae yellow, head and body darker, brown, the former practically without markings, the abdomen with some paler marblings. Frontal spine porrect, stramineous; pubescence short, grayish. Prothorax longest, metathorax shortest; thorax and head conspicuously granulate. Abdomen long and smoothly clavate, widest at distal part of fourth segment. Seventh tergite nearly square, the hind margin declivate, the posterior angles and median tubercle slightly and about equally produced; eighth tergite semicircular, carinate medianly, corrugated laterally; ninth as described in key. Seventh sternite moderately convex medianly, concave laterally.

Length, 18 mm.

*Holotype.*—Female, Sarare, Venezuela, 1896, F. Geay (Paris Mus.).

A teneral female, same data, apparently of the same species, is 21 mm. long.

### GHILIANELLA PASCOEI Bergroth.

*Ghilianella pascoei* BERGROTH, E. Ploeariinen 1906, pp. 315–317 [Venezuela].

*Male.*—General color dark reddish brown (less mature specimens yellow-brown, variegated with darker), hairs numerous but short and little aggregated into patches; abdomen widening gradually from base to hypopygium; seventh tergite a fourth longer than sixth, somewhat corrugated transversely on posterior two-thirds; second sternite slightly sinuate laterally, third and fourth almost transverse, fifth rounded emarginate medianly, sixth almost transverse, seventh and eighth shallowly emarginate medianly, slightly convex laterally, spiracle of latter included within border of segment; hypopygium rather short, claspers oblong, narrowed apically the upper margin convex (fig. 175). Sternites 2–7, finely wrinkled transversely.

*Female.*—Color as in male; in pale specimens the abdomen is marbled and leg markings are evident; abdomen widening gradually from base to juncture of fourth and fifth segments, narrowing little posterior of that point; connexivum more or less carinate; hind margins of tergites 2–6 very slightly elevated medianly, otherwise unmodified; tergite 7 with the posterior angles prominent and very slightly flaring, middle of hind margin with a small angulate prominence, extending about as far posteriorly as lateral angles, margin between prominences slightly concave and declivate; eighth tergite rather long, convex posteriorly, short median line, two transverse lines near upper end of former, and margin, slightly elevated, arcuate both transversely and longitudinally, median line almost carinate on upper third, apex rounded; hind margins of sternites 2–6 emarginate medianly, 6 most so, this sternite a fourth longer on side than on middle (fig. 176); seventh sternite a third longer than sixth on median line, its hind margin convex medianly, concave laterally, eighth sternite visible as an elliptical plate on each side, or when exposed, rounded emarginate medianly, convex laterally.

Length, 17–22 mm.

Pair from La Guaila, Venezuela (Coll. E. Bergroth), male, the type. Three males, Trinidad, March 26, 1916, R. A. Wood (Acad. Nat. Sci. Phila.); one male Botanic Garden, Port-of-Spain, Trinidad, Oct. 13, 1918, Harold Morrison (U.S.N.M.).

Females agreeing with *pascoei* in general appearance and in most characters but differing in details of eighth and ninth tergites from the female assigned to this species by Bergroth are left without definite determinations for the present. All of these have the head and thorax conspicuously granulate, the sternites finely corrugated transversely, and both sternites and tergites up to and including 7 similar to those of *pascoei*. Three from Trinidad, March 26, 1916, R. A. Wood (Acad. Nat. Sci. Phila.), and one from Montserrat, Trinidad, June 29, A. Busck (U.S.N.M.), have the eighth tergite depressed medianly, with transverse wrinkles or irregular elevations each side of the depression; and ninth tergite is arcuate both transversely and longitudinally, but is depressed apically and more or less concave between the apices of the somewhat elevated lateral margins. A single female from Ivon Beni, Bolivia, January, 1922, M. R. Lopez (U.S.N.M.), has the eighth tergite distinctly carinate medianly and corrugated transversely on each side; the ninth tergite has a median carina above which widens so as to cover the whole apex, this part of the tergite being distinctly elevated above the sides of the disk, apex truncate. While these variations are rather greater than we should expect in a single species, the weight of evidence in hand seems to be against attributing them to specific distinctness.

### GHILIANELLA ALTERATA, new species.

*Female.*—Dark castaneous; beak, antennae and mid and hind legs yellow-brown but unmarked; frontal spine stramineous. Head and thorax copiously granulate and yellowish-white haired; prothorax longest, metathorax shortest of the three divisions. Abdomen smoothly clavate, attaining its greatest width at posterior part of fourth segment; tergites except 1, longer than wide, seventh with the posterior angles prominent but not produced, median portion declivate and triangularly produced, slightly surpassing lateral angles. Eighth tergite short and broad, faintly rugose; ninth much longer, narrowing rapidly and rounded apically; middle of apex and some irregular small areas each side of the median line depressed. Seventh sternite moderately subangulately produced in the middle of hind margin, concave laterally.

Length, 22 mm.

*Holotype.*—Female, Sarare, Venezuela, 1899, F. Geay (Paris Mus.).

### GHILIANELLA MACULATA, new species.

*Male.*—Head, thorax and legs yellow brown; frontal and femoral spines pale; abdomen reddish brown; pilosity of head and thorax gray, abundant, markedly pollinose; pile of abdomen pale tawny, aggregated into irregular spots especially on segments 3–6, spots more numerous anteriorly and on sides of both tergites and sternites; abdomen nearly circular in cross-section, forming almost a smooth· cone based on hypopygium; seventh tergite a little longer than sixth, transversely corrugated on posterior third, tapered from the middle, and apiculate, terminating in a moderate point which extends well beyond hypopygium. Sternum without keel; sutures between sternites emarginate medianly, arcuate laterally, this condition most pronounced between sixth and seventh; eighth sternite almost transverse posteriorly, with a narrow rounded emargination; ninth sternite very narrowly visible, with a similar but smaller emargination; claspers closely fitting the upper margin of hypopygium, their own upper margin broadly emarginate medianly. Fore leg and its armature as in figures 185 and 186.

Length, 28 mm.

*Holotype.*—Male, Cayamas, Cuba, Jan. 16, E. A. Schwarz. (U.S.N.M.)

*Type.*—Male, Cat. No. 26744, U.S.N.M.

### GHILIANELLA PERSONATA, new species.

*Male.*—Light to dark reddsh-brown, almost uniform; head and thorax without granulations, short gray slightly flocculent pubescence abundant, much shorter and less conspicuous on abdomen. Abdomen widening gradually to hypopygium, dorsum convex, without ridges or tubercles, sutures mostly obsolete; seventh tergite long, narrowed gradually from a point two-fifths of its length from base, terminal fifth more abruptly tapering, moderately pointed, thickened and projecting beyond hypopygium. Sternum unkeeled, ventral sutures as described in key, hind margin of seventh sternite nearly straight, and eighth narrowly and slightly emarginate; ninth sternite or hypopygium long, with a transverse impression bounding the thickened margin, opening upward and backward, the apex projecting as a rounded triangle, the claspers broadly triangular, (fig.

177), filling the space between hypopygium and seventh tergite, except for a narrow vertical space between their apices.

*Female.*—Color and pubescence as in male; abdomen widening gradually from base, the dorsal sutures evident; seventh tergite with the hind angles moderately produced as obtusely pointed processes, margin between distinctly concave, without tubercle; eighth tergite semielliptical, with a median carina interrupting the transverse corrugations; ninth tergite rather short, median carina and cross corrugations low, indistinct, apex narrowly rounded. Seventh sternite moderately produced medianly as a rounded lobe, the sides of hind margin concave; eighth sternite visible only as a long ellipse on each side.

Length, 25–28 mm.

*Holotype.*—Male, paratype male, allotype female, Chapada, Brazil, collected in July, April, and August, respectively (Carnegie Mus.).

### GHILIANELLA CLAVIVENTRIS Bergroth.

*Ghilianella claviventris* BERGROTH, E. Ploeariinen 1906, pp. 318–9 [Venezuela].

*Male.*—Dark reddish-brown, frontal spine, connexivum, hind edge of sixth tergite, posterior third of seventh and a few other edgings, yellowish. Head and thorax scarcely granulate; pale reddish pubescence very short, fine and sparse. Abdomen widening gradually to apical fourth of fourth segment, which is abruptly inflated and together with the fifth and most of the sixth segment forms a globular expansion of the abdomen; remainder of abdomen tapering posteriorly and upcurved. The fifth tergite is finely longitudinally strigate and is smoothly inflated, without ridged elevations laterally. The sixth tergite is distinctly trisinuate posteriorly, and the seventh narrowing from the basal third, has the posterior half transversely wrinkled and an acuminate apex which slightly surpasses hypopygium. Sutures between sternites concave anteriorly, that between sixth and seventh most so; hind edge of seventh conspicuously emarginate medianly and only slightly less so laterally; eighth sternite visible on its entire width, nearly straight posteriorly; ninth sternite, or hypopygium, rather long, more or less granulate and transversely wrinkled, opening upward, claspers oblong, somewhat upturned and bluntly pointed at apex.

Length, 26 mm.

Two males, Colonia Tovar, E. Simon 1.11.88 (Coll. E. Bergroth). One the type. Another male Cerro del Avila, 6,000 feet, Venezuela, December, 1913, S. M. Klages (Carnegie Mus.).

### GHILIANELLA GLOBIFERA Bergroth.

*Ghilianella globifera* BERGROTH, E. Ploeariinen 1906, pp. 319–320 [Venezuela].

Color throughout dark reddish-brown, legs and antennae without pale markings; the sharp downwardly slanting frontal spine, most of beak, the spiracles and edgings on genital segments pale. Gray pubescence rather plentiful, a little more prominent on fourth to sixth sternites and in two percurrent lines on dorsum. Bulbosity farther forward than in any other species examined, widest at fourth segment and sixth not at all involved in it; seventh tergite long, the process making up two-thirds of length, wrinkled transversely, ridged longitudinally, and punctate apically, rather pointed. Seventh sternite well exposed, eighth moderately long, opening upward, claspers oblong, narrowed and incurved apically.

Length, 19 mm.

Male, Caracas (Coll. E. Bergroth.). The type.

Two males, Sarare, Venezuela, F. Geay, 1896; and two (one teneral and damaged), Llanos, Venezuela, F. Geay, 1896 (Paris Mus.).

Length of these specimens, 18.5–20 mm.

### GHILIANELLA PERVERSA, new species.

*Female.*—Legs testaceous with more or less distinct dark bands, ground color elsewhere testaceous, but obscured largely above, and almost entirely below, by fuscous to black marbling; granulations prominent on head, inconspicuous on thorax; pubescence short and fine; proportions of pro-, meso-, and meta-thoraces as 8, 6, and 3; abdomen widening gradually to junction of fifth and sixth segments, tapering gradually posteriorly; unusually narrow median strips of tergites with indistinct longitudinal ridge; hind margin of tergite 6 with a prominent backwardly projecting tubercle; that of tergite 7 with a short, porrect, blunt tubercle from which the margin slopes away on each side to the simply rounded lateral angles; eighth tergite nearly as long as wide, the general form broadly elliptical, the disk wrinkled and granulate, the apex apiculate. Hind margins of all sternites more or less sinuate laterally, 3 least and 6 most so, the latter sternite a fourth wider on sides than in middle; seventh sternite slightly convex medianly and concave laterally; eighth visible as an elliptical plate on each side (fig. 178). Appearance of female hypopygium from rear as in figure 179.

Length, 18 mm.

*Holotype.*—Female, Aracataca, Magdalena, Colombia, August 12, 1920, in heavy forest with dense undergrowth, J. A. G. Rehn (Ac. Nat. Sci. Phila.).

### GHILIANELLA APICULATA, new species.

*Male.*—General color dull blackish, pale vestiture unusually abundant, patch at anterior end of metathorax crossing the notum, pubescence on top of abdomen arranged in lines; beak, frontal and hypopygial spines pale yellow to reddish, spiracles concolorous; sixth tergite with a slight prominence on middle of hind margin; sternum without keel; sternites 4–6 more or less emarginate medianly and sinuate laterally, this feature becoming more pronounced posteriorly; seventh sternite broadly emarginate medianly, eighth about transverse; ninth with supero-posterior angles prominent, extending as far posteriorly as base of hypopygial hook (fig. 180), the latter anteriorly and upwardly directed, the apex bent forward, divaricate, and apparently otherwise modified.

Length, 27 mm.

*Holotype.*—Male, Blanton Mine, north of San Christobal, Republic of Dominica, July 26, 1919, Harold Morrison (U.S.N.M.).

*Type.*—Male, Cat. No. 26745, U.S.N.M.

### GHILIANELLA ICA, new species.

*Male.*—Color castaneous, chiefly dark, scarcely relieved by pale markings. Frontal process mammiform; head and thorax scarcely granulate. Seventh tergite narrowed gradually from middle to near apex, then rather abruptly pointed, transversely corrugated on posterior half. Seventh sternite rounded emarginate medianly, almost straight laterally; eighth nearly straight posteriorly, spiracle moderately pedicellate; ninth rather long, opening upward, a little elevated along hind margin which is produced between the claspers, where it bears the anteriorly directed somewhat curved process, which is a little widened and slightly concave at apex; claspers oblong, beveled off on lower side at apex.

Length, 28 mm.

*Holotype.*—Male, Rio Ica, Crevaux, 1880 (Paris Mus.).

### GHILIANELLA PACHITEA, new species.

*Male.*—Differs from *pascoei* Bergroth in having the ventral spines on fore femora and the one between the bases of antennae dark brown instead of stramineous; also the spine between bases of antennae is much stouter and a little shorter than in *pascoei;* the cross striation of abdominal sternites is much finer than in that species, and the hypopygium is as in figure 181.

Length, 22 mm.

*Holotype.*—Male, Pachitea, Peru (Bueno).

### GHILIANELLA COLONA, new species.

*Male.*—Similar in general to *G. aracataca*, but the pubescence of head and thorax less abundant and none of it pollinose; abdomen gradually widening to seventh segment, which differs from that of *aracataca* as described in key; eighth sternite almost straight on hind margin, the spiracles conspicuously pedunculate.

Length, 22 mm.

*Holotype.*—Male, Don Diego, Dept. Magdalena, Colombia (Carnegie Mus.). A nymph with same data probably is this species.

### GHILIANELLA BETHEI Dohrn.

*Ghilianella bethei* DOHRN, A. Nachträge, 1863, pp. 68–70 [Bogota].

*Female.*—Fuscous, relieved by ochraceous spots and clouding; leg bands faint. Head and thorax distinctly granulate, short pale pubescence rather abundant, that of abdomen shorter and less plentiful. Frontal spine pale, decurved. Abdomen widening to apex of fifth segment and narrowing gradually to end, clavate rather than bulbous in shape. Fifth tergite with angular dilatations near hind angles, sixth with a prominent, acute, falcate tubercle; seventh nearly straight across hind margin, the middle of latter slightly elevated and with a short pointed tubercle; eighth tergite semi-circular, transversely rugose, but scarcely longitudinally carinate; 9th rather inflated basally, obsoletely rugose, depressed subapically, with the apical margin rounded and elevated. Sutures between sternites inclined anteriorly and showing more or less anterior curvature medianly; hind margin of seventh moderately angulate, prominent medianly and slightly concave laterally.

Length, 20–22 mm.

Cacagualito, Colombia, May; Bonda, Colombia, June (Carnegie Mus.).

The specimens listed seem to answer well to the original description, the only real discrepancy being that none of them show "a slight cross furrow" on the apical half of tergite 5. However, this appearance in Dohrn's specimen may have been due to bending at the time of capture or to some effect of drying.

### GHILIANELLA ARACATACA, new species.

*Male.*—Dark reddish-brown, pubescence rather abundant, more or less pollinose in character anteriorly; beak yellow-brown, frontal spine whitish, leg bands moderately distinct; abdomen gradually widened to fifth segment, sixth narrowed, seventh swollen, as thick as fifth; tergites slightly elevated at the middle of their posterior margins, seventh twice as long as sixth; sternites 2–7 more or less emarginate apically and sinuate laterally, the sixth most pronounced in these respects, eighth with a small, triangular median projection, the supero-posterior angles rounded, and the spiracles not conspicuously pedunculate (fig. 182).

*Female.*—Similar to the male in color, pilosity somewhat less conspicuous, pollinosity rather more so; abdomen widest at fifth segment, tapering gradually both fore and aft, tubercle of sixth tergite, projecting posteriorly, bluntly falcate; seventh tergite with a straight median porrect process extending considerably beyond the prominent but not produced lateral angles; eighth tergite rounded triangular somewhat broader than long; ninth with the sides convexly sloping apically, the median line keeled and apiculate (fig. 183); sternites 2–4 slightly emarginate medianly, and sinuate laterally, entire posterior margins of sternites 5 and 6 anteriorly arcuate, the latter most deeply, this sclerite being a fifth longer on sides than in middle; seventh sternite concave on sides of posterior margin, with a rather prominent rounded median projection; eighth sternite visible as an elliptical plate on each side (fig. 184).

Length, 22–24 mm.

*Holotype.*—Male and allotype female, Aracataca, Magdalena, Colombia, Aug. 6, 1920, in heavy forest with dense undergrowth, J. A. G. Rehn (Acad. Nat. Sci., Phila.)

### GHILIANELLA CUNEATA, new species.

*Female.*—Yellowish to reddish brown, the leg bands more or less distinct, the abdomen marbled with fuscous; pubescence in no way unusual; abdomen widened gradually to apex of sixth segment, then tapering to apex of seventh; hind margin of all of the tergites prominent medianly, sixth with large slightly falcate tubercle, and the posterior angles a little prominent and expanded; the hind margin of the seventh with a short, median, pointed tubercle which extends slightly farther posteriorly than the prominent lateral angles; eighth tergite considerably wider than long, with transverse corrugations and a central keel which is produced in a point slightly beyond general line of the posterior margin; ninth tergite much longer than eighth, somewhat wrinkled transversely, the narrowed apex with a broad prominent keel; sutures between sternites 2–6 slightly anteriorly directed, that between six and seven quite concave anteriorly; sternite seven about a fourth longer than six on the median line, its hind margin slightly concave laterally, somewhat produced medianly, the extreme apex with a small emargination; eighth sternite narrowly visible on each side.

Length, 23–26 mm.

*Holotype.*—Female, Alhajuelo, Panama, April 18, 1911, Aug. Busck; five female paratypes, Porto Bello, Panama, March 16, 1911, Feb. 19, A. Busck; Feb. 17, 1911, E. A. Schwarz; Upper Pequiru River, Camp No. 3, Panama, A. H. Jennings; Buena Ventura, Panama, March 1911, A. Busck (U.S.N.M.).

*Type and paratypes.*—Female, Cat. No. 26746, U.S.N.M.

### GHILIANELLA ASSA-NUTRIX Bergroth.

*Ghilianella assa-nutrix* BERGROTH. Ploeariinen 1906, pp. 314–5 [Venezuela].

*Male.*—General color dark reddish-brown, frontal spine pale; the usual patches of pilosity a little more extensive than in average species, the metathoracic patches contiguous over dorsum, color of pile in general sordid yellowish, tending to be golden in the denser patches; in addition to the typical patches there are two small rounded spots on the posterior margin of each tergite from 2–6, largest on 4; most of the first tergite and adjacent disk of second also are covered by a patch of golden pubescence; seventh tergite more than twice as long as sixth, strongly transversely corrugated about the middle, and tapering apically into a long, roof-shaped, pointed process which exceeds hypopygium by more than length of latter; sternum unkeeled; sutures between sternites directed moderately forward; posterior margin of six and seven rounded emarginate medianly, and arcuate laterally; eighth narrow, transverse, spiracle moderately pedunculate; hypopygium with a terminal, anteriorly and upwardly directed hook, margin receding and arcuate each side of this; claspers oblong, bluntly rounded apically (fig. 187).

*Female.*—Color and pubescence as in male. Abdomen widening gradually from anterior part of second segment to about middle of fifth, and increasing in depth, as seen from side, to anterior part of seventh segment. Hind margins of tergites 1–5 nearly straight, of six slightly convex posteriorly, of seven slightly prominent medianly, concave each side of this, with acute divergent lateral processes as described in key; eighth tergite short, semielliptical, depressed medianly, and with obliquely transverse wrinkling each side of the depression; ninth tergite longer than eighth, an oblique impression each side of middle near base, the median line elevated, especially near apex, where it forms a distinct carina joining the raised apical margin; the surface near apex is polished, with two subsidiary oblique ridges each side of the median one. Hind margins of sternites more or less concave posteriorly, that of six most so; seventh slightly convex medianly, and concave laterally; eighth moderately exposed, the spiracle barely visible from the side.

Length, 28–30 mm.

Male and female San Esteban, Venezuela, March, 1888, E. Simon (Coll. E. Bergroth). One the type.

Two males, San Esteban, Venezuela, Oct.–Nov., 1910, M. A. Carriker, jr. (Acad. Nat. Sci. Phila.). One male, Caracas (Cophenhagen Mus.).

### GHILIANELLA GLADIATOR, new species.

*Male.*—General color dark reddish-brown, pilosity much more abundant than usual, short, grayish; abdomen widest at fifth segment, tapering gradually both fore and aft; seventh tergite twice as long as sixth, with a projection similar to that of *assa-nutrix;* all sternites more or less emarginate medianly and arcuate laterally, 6 and 7 most pronouncedly so; eighth varying from slightly emarginate to transverse, narrow, spiracle moderately prominent; hypopygial spine small, margins not excavated each side of it, claspers long, narrow, slightly enlarged apically (fig. 188).

*Female.*—General color reddish-brown to blackish; short, fine yellowish pubescence abundant, much denser than usual on head and thorax, particularly about rear parts of the posterior divisions of the latter and on the fourth and fifth tergites; bulbosity of abdomen rather long, including half of fourth, all of fifth and sixth, and half of seventh segments; sutures between tergites 2–7 all nearly transverse; the ninth tergite is narrowly keeled along the sides, and more prominently elevated medianly, especially at the narrowed apex; the sutures between sternites 2–5 slope anteriorly, the hind margin of the fifth is emarginate medianly and arcuate laterally, and that of the sixth concave throughout; the seventh sternite is prominently angulate produced medianly, and the eighth is narrowly visible on each side.

Length, 24–26 mm.

*Holotype.*—Male, allotype female, and paratype male, Trinidad, March 26, 1916, R. A. Wood. (Ac. Nat. Sci., Phila.)

*Paratype.*—Female, Port-of-Spain, Trinidad, F. W. Urich (U.S.N.M.), Cat. No. 26747, U.S.N.M.

The latter specimen is accompanied by some eggs (figs. 189, 190) and newly emerged nymphs; the former are 1.75 mm. in length, with sparse longitudinally arranged, irregular granulations, a nipple-like longitudinally striate cap, which is surrounded by about 18 delicate, tapered, and finely pointed appendages of the main egg case, the apices of which are bent inward at about the same level as peak of the cap (fig. 189). The nymphs are notable chiefly for the surprisingly advanced state of development of the thorax and its appendages, and for the very undeveloped condition of the abdomen; they are certainly equipped for capture before digestion of prey.

The males and females here listed are associated as one species not only because of their general agreement in color and form but specifically because they share a character unusual in the genus, namely, absence of central keel on meta- and meso-sterni.

### GHILIANELLA STIPITATA, new species.

*Female.*—Much like the same sex of *G. filiventris* except in shape of abdomen and details of genital segments. Length of prothorax and mesothorax as 3 is to 4. The abdomen is smoothly, almost round clavate, with the fifth segment the largest in all dimensions; tergites 4–7 are relatively longer than in *filiventris*, the last especially being distinctive as described in key (fig. 191). Eighth tergite rather long and narrow, the middle line and margins slightly elevated, apex rounded; ninth tergite longer than eighth, narrowing and rounded apically, the median line, some irregular oblique branches from it, and the apex somewhat elevated. Seventh sternite rather strongly and acutely produced medianly, concave laterally.

Length, 25 mm.

*Holotype.*—Female, Llanos, Venezuela, 1895, F. Geay (Paris Mus.).

### GHILIANELLA SIMILATA, new species.

*Female.*—Much like *stipitata* in form, but head and thorax decidedly less granulate, and the mid and hind femora each with 3 pale bands on apical half, instead of unicolorous as in that species. Length of prothorax and mesothorax as 3.75 is to 4. The seventh tergite is as described in key, the eighth nearly semicircular, depressed medianly, and obscurely wrinkled; ninth about as long as eighth, but considerably narrower and somewhat tapered posteriorly, margins and median line elevated, apex blunt, slightly convex. Venter as in figure 192.

Length, 19–20 mm.

*Holotype.*—And another female, Caracas, Meinert (Copenhagen Mus.).

### GHILIANELLA PENDULA, new species.

*Ghilianella bulbifera* CHAMPION (females) Biologia, vol. 2, p. 171, fig. 18, Oct. 1898. [Bugaba, Panama.]

*Female.*—Color varying from yellowish- to dark reddish-brown, the paler specimens have the abdomen more or less variegated with fuscous and the leg bands more distinct; pubescence and granulation in no way unusual. Abdomen rather smoothly clavate, widest at fifth and sixth segments (the sixth tergite widest), but the bulbosity includes the entire sixth segment; posterior angles and middle of hind margin of segments 4–7 prominent, most conspicuously so on six where the median elevation is a large slightly posteriorly inclined cone; on the hind margin of seventh tergite a small triangular prominence extends slightly farther posteriorly than the prominent but blunt lateral angles; eighth tergite broader than long, rounded apically, ninth a trifle longer than eighth, narrowed, and the margins raised apically, but 8 and 9 with low median keels and more or less corrugated; hind margins of sternites 4–6 emarginate medianly, arcuate laterally, the lateral convexity on 6 being almost angulate; seventh sternite a third longer than 6, slightly angulate-produced medianly; eighth narrowly visible on each side.

Length, 21–24 mm.

*Holotype.*—Female, Cabima, Panama, May 18, 1911, Aug. Busck; paratype female, Alhajuela, Panama, A. H. Jennings; another female without locality.

*Type and paratype.*—Female, Cat. No. 26748, U.S.N.M.

For disposition of males of *bulbifera* see page 97.

### GHILIANELLA APPROXIMATA, new species.

*Male.*—Head, thorax and appendages, bulbosity and hypopygium piceous, remainder of abdomen chiefly, frontal spine, anterior tibia and tarsus, and spines of front femur, yellow-brown or paler. Pubescence sordid gray, rather dense and matted over thorax and in patches elsewhere. Bulbosity formed chiefly by fifth segment, fourth and sixth only slightly involved. Seventh tergite rather long, neither wrinkled nor coarsely punctate as in many species, rather sharply apiculate and slightly surpassing hypopygium. Sternites of ordinary form, eighth almost straight across on hind margin, slightly concave laterally, moderately exposed. Ninth sternite long, opening upward, claspers oblong, pointed apically.

*Female.*—Generally paler than male, with edgings and much marbling of yellow-brown; legs with usual pale markings. Mesothorax shorter than in male, but longer than either of its fellow thoracic parts. Bulbosity involving more of fourth and sixth segments, the elevations of fifth tergite more remote from lateral margins than in male. Hind margin of sixth tergite concave each side the median point, which is about as far produced posteriorly as the rounded lateral angles; hind margin of seventh tergite of similar shape, declivous each side of median prominence; eighth tergite semi-circular, low carinate medianly and radiately corrugated each side in best developed specimen; ninth longer, narrowed and notched at apex, the margins elevated above the disk which has three coarse transverse wrinkles. Eighth sternite broadly exposed, angles each side the median cleft are thickened, pointed, black, and with a tuft of long golden hairs.

Length, 24–25 mm.

*Holotype.*—Male, Rurrenabaque, Bolivia, Oct. 1921; allotype female, Huachi, Bolivia, 1922; another female Corenda, Bolivia, 1921, and two males, Huachi, Bolivia, Sept. 1921, W. M. Mann (U.S.N.M.).

*Type, allotype, and paratypes.*—Cat. No. 26749, U.S.N.M.

### GHILIANELLA GLOBULATA, new species.

*Ghilianella ignorata* CHAMPION, Biologia, vol. 2, pp. 170–171, pl. 10, figs. 15–16, 1898 [Mexico, Honduras, Guatemala, Panama], not of Dohrn, Emesina, 1860, pp. 238–9, pl. 1, figs. 9–11 [La Guayra and Brazil].

*Male.*—Color dark reddish-brown, sometimes with irregular dark maculations, legs and antennae without pale annuli or sometimes with markings as described for female; head and thorax strongly granulate; segments 2–4 of abdomen slender, widening gradually to apical fourth of fourth, which is abruptly expanded, bulbosity composed chiefly of the fifth segment which is about three times as wide as anterior part of fourth; fifth tergite angulate dilated at about middle of sides, margin receding abruptly behind the dilation; sixth segment about half as wide as fifth, the tergite rounded emarginate posteriorly; seventh tergite about twice as long as sixth, projecting considerably beyond hypopygium, strongly transversely corrugated, and with a conspicuous central keel on posterior half. Sixth sternite with a rather deep rounded median emargination, seventh emarginate, both medianly and laterally, eighth transverse, narrow; hypopygium inflated, with a slightly projecting, moderately large terminal hook, the tip of which is concealed between the oblong claspers (fig. 194).

*Female.*—Color somewhat paler, front femora with two partial bands, mid and hind femora with two bands and a subapical spot, and hind tibiae with subbasal spot, pale; the abdomen is stouter throughout, the fourth and fifth segments in particular being broader and more involved in the bulbosity; sixth tergite slightly emarginate and a little elevated in the middle behind; seventh tergite equally but only slightly prominent; eighth tergite about a third shorter than ninth, the latter transversely wrinkled and longitudinally keeled, depressed on each side of keel apically; fifth sternite shallowly and sixth more deeply emarginate posteriorly; 7th with a short rounded projection; eighth sternite visible as a narrow elliptical plate on each side.

Length, 23–26 mm.

*Holotype.*—Male, Cacao Trece Aguas, Alta Vera Paz, Guatemala, April 9; allotype female, same locality April 23, 8 male and 4 female paratypes, same locality, March 27, 29, 30, April 2, 7, 15, 18, 22, 26, 29, E. A. Schwarz and H. S. Barber; 1 male paratype, same locality June, 1907, and 1 female Nov.–Dec., 1906, G. P. Goll; 1 female, Polochi River, Guatemala, March 22, Barber and Schwarz, 1 male, La Ceiba, Honduras, Jan. 24, 1916, F. J. Dyer (U.S.N.M.); 1 female, Yurimaguas, Peru, June 14, 1920, H. S. Parish (McAtee).

*Type, allotype, and paratypes.*—Cat. No. 26750, U.S.N.M.

*Nymphs.*—Several nymphs presumably of this species are at hand from Cacao, Trece Aguas, March 27 to April 26. There is a rather prominent triangular elevation on the middle of the hind margin of each tergite, that on the seventh being most prominent and angularly projecting; the lateral angles also are tuberculate prominent; the eighth and ninth tergite roofing the anal tube of the female have only suggestions of the corrugations and keels they later acquire.

### GHILIANELLA PATRUELA, new species.

*Male.*—Color dark reddish brown, pale markings of legs merely suggested; granulations of head and thorax nearly obsolete, a few small ones on sides of mesothorax; abdomen about as in *strigata*, lacking the wartlike elevations, however, and the suture between the fourth and fifth tergites is straight across, instead of posteriorly convex as in that form; all sternites rounded emarginate medianly, arcuate laterally, the posterior ones more pronouncedly so; hypopygium rather long, the posterior margin bisinuate on each side, the lower angle conspicuous but by no means so much so as in *strigata*, the more slender genital hook arising from within the angle and directed posteriorly and upwards, the apex simply truncate; claspers and fifth sternite as described in key (fig. 194).

Length, 20 mm.

*Holotype.*—Male, San Carlos, Costa Rica, Schild and Burgdorf. (U.S.N.M.).

*Type.*—Male, Cat. No. 26751, U.S.N.M.

### GHILIANELLA RECONDITA, new species.

Color reddish-brown to pitchy-black, legs and antennae without pale annuli, spines of fore tibiae yellowish; spine between antennae also yellowish, and with an enlarged base; head, and thorax distinctly granulate.

*Male.*—Segments 2–4 of abdomen very slender, the fourth abruptly expanded apically, forming anterior fourth of the bulbosity; the latter composed chiefly of the fifth segment which is greatly expanded, the sides elevated and forming rather pointed tubercles somewhat behind the middle; sixth segment posteriorly only a third as wide as fifth and somewhat shorter; seventh tergite almost twice as long as fifth, acuminate apically and projecting somewhat beyond hypopygium (fig. 195); seventh sternite slightly emarginate at the middle of hind margin, eighth half as long as the seventh.

*Female.*—Segments 2–4 of abdomen less slender, the fourth not so abruptly expanded, about half of sixth segment involved in the bulbosity (fig. 196); seventh tergite slightly bisinuate apically, the posterior lateral angles and median convexity not at all prominent; eighth tergite about as long as ninth, the latter not especially modified apically, that region being only slightly impressed medianly; fourth and fifth sternites broadly but shallowly emarginate at the middle of hind margin; seventh sternite slightly angulated at middle of hind margin; eighth sternite narrowly visible on each side of hypopygium.

Length, 18–20 mm.

*Holotype.*—Male, allotype, female, and 3 paratypes, 2 males and 1 female from Minca, Magdalena, Colombia, 2,500 feet, July 24–25, 1920, and 1 paratype male from Aracataca, Magdalena, Colombia, dense undergrowth, J. A. G. Rehn (Acad. Nat. Sci., Phila.).

### GHILIANELLA PERIGYNIUM, new species.

*Male.*—Similar to *recondita* in many respects, but longer and with more abundant grayish-yellow pile; general color reddish-brown, connexivum of segments 2–4 narrowly pale; hypopygium much as in *recondita*, claspers differing as described in key (fig. 197); seventh sternite more deeply emarginate and sixth sternite also with a broad, deep median emargination.

*Female.*—Similar in color to male, tending to be somewhat paler with dark mottlings; structure about the same as in female of *recondita*, eighth tergite not depressed medianly near apex and the latter somewhat flaring or upturned and notched medianly, while it is rather rounded off in *recondita;* hind margin of seventh sternite concave laterally, convex medianly, with a slight emargination at the extreme apex.

Length, 23–28 mm.

*Holotype.*—Male, allotype female, and one paratype female, Pachitea, Peru (Bueno).

### GHILIANELLA SIGNATA, new species.

*Female.*—General color dark reddish brown, shading to blackish on distal parts of legs and abdomen; head and thorax unusually free from granulations, some present along dorsal carinae of mesothorax; pile pale tawny, distribution on head and thorax about typical, aggregated into scattering minute tufts and regularly arranged large patches on abdomen, a pair of latter on posterior margin of fourth tergite, and a pair covering postero-lateral angles of fourth, fifth, and sixth sternites; bulbous expansion of abdomen including fifth segment, posterior third of segment 4, and anterior third of segment 6; lateral elevations of segment 5 somewhat posteriorly directed, a little wrinkled dorsally and bluntly falcate; segments 6 and 7 conjointly elevated at middle of suture, the elevation surmounted by a minute nipple on 6; tergite 7 a little longer than 6, hind margin moderately prominent medianly and laterally, thus being slightly bisinuate; eighth tergite much broader than long, broadly rounded apically, strongly corrugated and keeled; ninth tergite pale basally, with broad, rounded, low, pale side margins; disk dark, corrugated, and keeled, the apex narrowed and bent so that it is at right angles to general plane of tergite (fig. 198); ventral sutures little specialized; hind margin of seventh sternite slightly angulate-produced medianly, concave laterally; eighth sternite rather broadly exposed each side, the spiracle, however, only barely visible, the hind margin deeply rounded emarginate medianly.

Length, 25 mm.

*Holotype.*—Female, Hacienda Cincinnati, Sierra San Lorenzo, Magdalena, Colombia, Trail to Vista Nieve, 4,500–4,700 feet, July 21, 1920, J. A. G. Rehn (Acad. Nat. Sci. Phila.); female paratype, Vista Nieve, Colombia, Dec. 16, 1922 (C. Carriker).

### GHILIANELLA STRIGATA, new species.

*Male.*—General color yellowish-brown, legs with faint yellowish annuli in the standard positions; the head and thorax are only obsoletely warty, almost smooth; the mesothorax and the metathorax with a few warts on the sides; abdomen abruptly expanded at posterior third of segment 4, segment 5 widest, the tergite with rounded elevations laterally; segments 2–5 each with a wart-like elevation on middle of hind margin, most conspicuous on 4; segment 6 rapidly tapering to about half width of 5; tergite 7 half again as long as 6, transversely corrugated posteriorly, moderately acuminate and extending slightly beyond hypopygium; sternites 6–8 rounded emarginate medianly, arcuate laterally, the eighth about a third as wide as seventh, the spiracle conspicuously pedunculate; ninth sternite longest on lower half, which forms apically a prominent rounded angle from which arises the long anteriorly and upwardly directed genital hook, the apex of which is bluntly trilobate; claspers and fourth sternite as described in key (fig. 199).

Length, 22–23 mm.

*Holotype.*—Male, San Carlos, Costa Rica; paratype male, Costa Rica, Schild and Burgdorf (U.S.N.M.).

*Type and paratype.*—Cat. No. 26752, U.S.N.M.

### GHILIANELLA SUBGLOBULATA, new species.

*Male.*—Practically a copy of *globulata* except in the following particulars. Pedicel of abdomen is shorter and thicker, each of segments 2–4 being shorter than width of bulbosity which the corresponding segments of *globulata* equal; sixth tergite not longer than wide at base, while it is distinctly longer in *globulata.* Ninth sternite not opening so nearly posteriorly as in *globulata*, the hook higher therefore, and less easily distinguished; claspers oblong, incurved at tips, each with a distinct rounded subapical notch in upper margin.

*Female.*—Females assigned to this species are still closer duplications of *globulata* than is the male, for the reason that the abdomen is short and the segments of the same proportions as in that species. The only tangible difference is that the posterior angles of seventh tergite are distinctly produced beyond median part of hind margin which is merely convex and not at all tuberculate.

Length, 19–21 mm.

*Holotype.*—And one other male, allotype female, Venezuela, Noualhier, 1898 (Paris Mus.); two other females, Maracaibo, Venezuela, Wibske (Copenhagen Mus.).

Two teneral and damaged females which may belong here have the prominences of fifth tergite more conspicuous, projecting distinctly beyond sides of abdomen. If assignment to the present species is correct the indication would be that these prominences may undergo a reduction from the condition attained in the nymphal or teneral state in the processes of ecdysis or hardening. The data for these specimens is Venezuela, one collected by G. Fallon, 1895, the other by Noualhier 1898 (Paris Mus.).

### GHILIANELLA UNCINATA, new species.

*Male.*—Color dark reddish-brown, head and thorax with more abundant short, semipollinose hair than usual in the genus; legs with faint pale bands disposed as in last species; abdomen a little stouter than in allied species, about a third of segment 4, and about half of segment 6 involved in the bulbosity; tergite 5 widely angularly emarginate anteriorly, tergite 6 almost transverse posteriorly, with a small rounded elevation on middle of hind margin; seventh tergite about half again as long as sixth, faintly corrugated, without keel but more or less apiculate, extending little if any beyond hypopygium. Sternites all more or less angulate emarginate posteriorly and sinuate laterally, the former condition most marked on 7, the latter on 6; eighth sternite plainly visible, shallowly rounded emarginate; ninth sternite long, straight, rather trough-like, terminating in a large, prominent hook; claspers oblong, narrowed above subapically, the apices turned inward and slightly upward (fig. 200).

Length, 21–25 mm.

*Holotype.*—Male, Trinidad Rio, Panama, March 29, 1912, A. Busck; paratype males same locality March 23, November 2, 5; Cabima, Panama, May 18, 1911; Alhajuelo, Panama, April 15, 1911; Porto Bello, Panama, March 10, 13, 1911; April 21, 1912, all A. Busck; last locality, Feb. 17, 1911, E. A. Schwarz; and no date, A. H. Jennings, 12 in all (U.S.N.M.).

*Type and paratypes.*—Cat. No. 26753, U.S.N.M.

### GHILIANELLA ATRICLAVA Bergroth.

*Ghilianella atriclava* BERGROTH, E. New Neotropical Ploeariinae. Psyche, vol. 18, No. 1, Feb., 1911, pp. 19–20 [French Guiana].

Body in general yellow-brown, bulbosity and legs piceous, the latter practically without pale markings. Frontal spine pale, short, decurved. Abdomen long pedicillate, increasing but slightly in thickness from base to posterior third of fourth segment which abruptly expands and together with the fifth and sixth segments forms an almost globular expansion beyond which the short seventh segment projects but little. Elevations of fifth tergite large, subacute, compressed, longitudinally ridged; sixth and seventh tergites very short, the latter transversely corrugated on the apical half, which is short acuminate; ninth sternite short, opening upwards, the claspers oblong, the upper posterior angles truncate.

Length, 24 mm.

*Male*, French Guinana (Coll. E. Bergroth). The type.

### GHILIANELLA FILIVENTRIS Spinola.

*Ghilianella filiventris* SPINOLA, M. Generi Insetti Artroidignati, 1852, pp. 143, 144 [Para].

Dohrn [19] describes and illustrates a species of *Ghilianella* as *filiventris* Spinola and it is upon this work that the present identification is based. Certainly the males before us are the same species that Dohrn figured; discrepancies in color from what he described are not a matter for concern in this genus. The specimens agree also with Spinola's description and some of them are from the type locality. The association of sexes here made is based on examination of a series of 18 specimens from the same locality collected at the same season, the genitalia of a number of which show evidences of recent use.

*Male.*—Color chiefly dark reddish (one specimen has peduncle yellowish); head and thorax copiously granulate; fine, short pubescence plentiful on head and thorax, sparse on abdomen and legs. Abdomen reaching the greatest degree of pedunculation seen in any species, segments 2, 3, and most of 4 forming a stalk of almost uniform diameter, the apex of fourth segment abruptly expanded, and together with the fifth and sixth forming a globular expansion which on account of the shortness of the seventh segment seems almost to terminate the abdomen (fig. 201); this is the only species observed to have ridged prominences near posterior angles of the sixth as well as on the fifth tergite; the seventh tergite has the basal portion almost square, this tapering rapidly into a short more or less upturned apiculation, slightly surpassing the hypopygium

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[19] Emesina, 1860, pp. 237, 238, pl. 1, figs. 8, 10.

(fig. 202). Sternites 5, 6, and 7 are shorter than in less bulbous species and each is broadly emarginate medianly; the ninth sternite or hypopygium is short and opens upward; the claspers are short-oblong, narrowed apically. Fore leg and its armature as in figures 203, 204.

*Female.*—In color like the male, with a greater tendency, however, to yellowish spotting or marbling; granulation and pubescence about the same. The abdomen widens gradually from base to apex of fourth segment, from which point to end of seventh the width is nearly uniform; it is thus a very good illustration of the clavate form; the median line of tergites is slightly elevated, subapically the lateral margins of tergite 6 tend to project beyond the common lateral outline of abdomen, and the hind margin of tergites 5 and 6 is bisinuate, the slight median angulation and the lateral angles projecting about equally posteriorly; hind margin of the seventh tergite slightly concave, with a distinct small median tubercle; eighth tergite almost semicircular, radiately wrinkled; ninth truncate cuneate, the base faintly transversely corrugated, the apex raised medianly, more or less concave distally, sometimes faintly longitudinally ridged; the hind margins of sternites 2 and 3 are emarginate medianly, those of 4, 5, and 6 are nearly simply concave; that of 7 is convex medianly and slightly concave laterally; and the exposed portions of 8 are elliptical.

Length, 23–27 mm.

Santarem, April–July 1919, S. M. Klages; Chapada, Para, all Brazil (Carnegie Mus.); a male labelled Amazon, Stevens (Stockholm Mus.); two females Itaituba, Amazon, Brazil, Noualhier, 1898; three males, Para, and one Amazonas, Noualhier, 1898 (Paris Mus.).

### GHILIANELLA MIRABILIS, new species.

*Male.*—Head and thorax moderately granulate; pubescence short; color castaneous, varying in depth, but without definite pale markings anywhere; frontal spine porrect, sharp, stramineous. Abdomen terete and of nearly uniform diameter from base to posterior fourth of fourth tergite which expands abruptly to form anterior wall of bulbosity. The largest component of the latter is the remarkably horned fifth segment described in key (figs. 205, 206), but the sixth segment is wholly included and the seventh is so short that the bulbosity is practically terminal. Seventh tergite an approximately equilateral triangle (fig. 207), corrugated transversely, and elevated and apiculate distally. Hind margin of the fourth sternite with a shorter and deeper median, and broader but shallower lateral concavities; fifth deeply concave, thus being very short on median line; sixth also deeply concave but of about same length in middle as on sides; seventh longer, with a short but distinct median emargination; eighth sternite barely visible; ninth short, strongly curved, opening upward; claspers oblong, narrowed apically.

*Female.*—Similar in general to male, but showing traces of pale leg markings, and abdominal marblings. Abdomen from base to and including fifth segment like that of male, the horns of fifth tergite shorter however (fig. 208); bulbosity much longer than in male, due to greater length of sixth and seventh segments which may be said to form part of it. Hind margin of seventh tergite with the median point and lateral angles slightly more prominent than intervening portions; eighth semicircular; ninth much longer, cuneate, faintly corrugated basally and striate apically, the apex rounded, margin slightly thickened (fig. 209). Sternites up to 6 inclusive of about same shape as in male, seventh much longer on median line than fifth and sixth together, the hind margin somewhat convex medianly and slightly concave laterally; eighth broadly exposed on each side.

Length, 27–29 mm.

Male holotype, female allotype, and a teneral male, Rio Autuz, Amazon, Roman (Stockholm Mus.).

### GHILIANELLA PERUVIANA, new species.

*Female.*—Dark castaneous, pubescence short and inconspicuous; head and thorax rather strongly granulate; central region of tergites with a percurrent ridge; a strong blunt tubercle at hind margin of 6; seventh with the hind margin nearly straight, bevelled off medianly on each side of the fairly prominent apex of longitudinal ridge; eighth tergite semicircular, considerably depressed medianly, with a low carina in the depression; ninth tergite tapering rather rapidly, rounded and slightly emarginate apically; with indistinct corrugations and no prominent longitudinal or marginal ridges.

Length, 22 mm.

*Holotype.*—Female, El Campamiento, Col. Perene, Peru, June 21, 1920, Cornell University Expedition, Lot 569 (Cornell Univ.).

### GHILIANELLA ANNECTENS, new species.

*Emesa angulata* UHLER, P. R. Heteroptera of St. Vincent, Proc. Zool. Soc. Lond., pp. 717–8, Nov. 21, 1893 [Panama specimens in part].

*Female.*—Testaceous, more or less variegated with fuscous and washed with rufous; thorax and head decidedly granular; pubescence sparse; abdomen widening gradually to apex of sixth segment, seventh somewhat narrower but nearly parallel-sided; tergites with a percurrent nodulose median ridge, becoming more prominent posteriorly and culminating in a large backward sloping tubercle on hind margin of tergite 6; posterior angles of tergites 3–6 progressively elevated and expanded, thus interrupting the lateral outline of abdomen as seen from above (fig. 210); seventh tergite almost straight across hind margin, the lateral angles slightly prominent and the median line near apex with a small recumbent tubercle which scarcely projects beyond the medianly depressed hind margin; eighth tergite broadly elliptical, wrinkled transversely and with a median keel which is elevated posteriorly and forms a small projection on hind margin; ninth tergite twice as long as eighth, with sinuate transverse wrinkles, a low median keel, the sides elevated and toothed posteriorly, the apex narrowed, depressed and black in color (fig 211); sutures between sternites while not greatly modified have a tendency toward median emargination and lateral sinuation; 6 is more concave behind and 7 somewhat produced medianly and concave laterally; an elliptical, vertically ridged and horizontally wrinkled portion of eighth sternite visible on each side. Armature of fore femur as in figure 212.

Length, 20 mm.

*Holotype.*—Male, Panama, Scudder (Uhler Collection, U.S.N.M.).

*Type.*—Male, Cat. No. 26754, U.S.N.M.

### GHILIANELLA TRUNCATA, new species.

*Emesa angulata* UHLER, P. R. Heteroptera of St. Vincent, Proc. Zool. Soc. Lond., pp. 717–8, Nov. 21, 1893 [Panama specimens, in part].

Very similar to the preceding; ninth tergite differing as noted in key; eighth with the median keel not projecting behind posterior margin (figs. 213, 214).

Length, 21 mm.

*Holotype.*—Female, labelled *Emesa angulata* Uhler, Panama (U.S.N.M.).

*Type.*—Cat. No. 27091 U.S.N.M.

### GHILIANELLA (PLOEODONYX) INSIDIATRIX Bergroth.

*Ghilianella insidiatrix*, BERGROTH, E. Konowia, vol. 1, pp. 219–220, August 20, 1922 [French Guiana].

*Male.*—Head and body dark, legs and antennae paler castaneous; front femora with 2 pale bands across the spined portion; antennae pale at base; mid and hind legs with faint pale annuli. Frontal spine short but pointed and decurved; head and thorax practically without granulation but prothorax is obsoletely rugulose; tubercles of pronotum each side of neck rather prominent, also a pair on hind margin; divisions of thorax successively shorter posteriorly. Pubescence golden, short and sparse in general, but aggregated in dense patches as follows: Posterior lobe of head above (front lobe also of more than average hairiness), top and sides of front end of pronotum, top and sides of thorax at sutures between meso- and meta-thoraces, and between metathorax and abdomen; upper surfaces of mid and hind coxae, first tergite, series of blotches practically forming a ring about abdomen at front of fourth segment, and similar patches or indications of them on following two segments. Abdomen widest about middle of fifth segment, holding its width well posteriorly, but narrowed considerably anteriorly especially segment 2; a slight elevation on the ampliate posterior angle of each tergite, and on middle of hind margin of sixth; median strip of dorsum with a series of squarish depressions; seventh tergite obsoletely ridged, wrinkled transversely on posterior half, narrowed in rounding fashion then abruptly apiculate, apex projecting slightly beyond hypopygium. Sternites of ordinary shape, seventh shallowly emarginate medianly, nearly straight laterally, eighth well exposed and broadly convex medianly, retreating laterally but not covered by seventh, spiracle moderately pedunculate; ninth sternite rather long, opening upward; claspers oblong, not narrowed apically. Fore leg and its armature as in figures 215, 216.

Length, 21–22 mm.

*Holotype.*—Male, French Guiana [Coll. Bergroth]. Other male specimens: Bourdonville, French Guiana, R. Benoist, August, 1914; Lunier River, Tumac Humac Mts., French Guiana, 1898, F. Geay; Napo River, Upper Amazon, 1899, Sarkady (Paris Mus.).

This series shows considerable variation in the extent of the patches of golden hair, and some in thickness of claspers, but these are not regarded as of taxonomic import.

We are accepting the female (allotype from French Guiana, examined by us) assigned to this species by Bergroth. His specimens of this sex apparently were collected at the same time and place as the males and probably are of the same species. However, among the three species of females of this group we have examined, one (*glabrata*) agrees better in structural characters with the male *insidiatrix* than does the specimen from Bergroth's collection. All of the females differ considerably from the male in characters other than those used in defining the subgenus. The frontal spine is much blunter, there are no patches of golden hair, and the leg markings are much fainter.

The allotype from Bergroth collection is pale castaneous, with the head and thorax almost free from granulations. The hypopygium is as described in key; the following details may be added: There is no longitudinal carina in the depression of tergite 8; and the apical margin of tergite 9 has on each side two ridges which are confluent medianly. Length, 25 mm.

### GHILIANELLA (PLOEODONYX) AMICULA, new species.

*Female.*—Description in most particulars would read like that of *insidiatrix*, from which the present species differs chiefly by hypopygial characters as described in key; eighth tergite is moderately long, squarish apically, with subobsolete radiating ridges.

Length, 23.5 mm.

*Holotype.*—Female, Charvein, French Guiana, November, 1914; R. Benoist (Paris Mus.).

### GHILIANELLA (PLOEODONYX) GLABRATA, new species.

A rather dark species with the head and body fuscous and the appendages yellowish to reddish-brown. Head and thorax practically without granulations; pubescence rather sparse, short, pale reddish. Central region of tergites nodulose but hardly tuberculate; hind margin of seventh tergite slightly concave, with a small median pointed tubercle. Eighth tergite almost semicircular, strongly transversely wrinkled; ninth tergite with a few strong cross wrinkles, tapering rather rapidly, otherwise as described in key.

Length, 24 mm.

*Holotype.*—Female, Essequebo River, British Guiana, July, 1921, Aug. Busck (U.S.N.M.).

*Type.*—Female, Cat. No. 26755, U.S.N.M.

### GHILIANELLA (LISSONYX) ANGULATA (Uhler).

*Emesa angulata* UHLER, P. R. A list of the Hemiptera-Heteroptera collected in the Island of St. Vincent by Mr. Herbert H. Smith, with Descriptions of New Genera and Species. Proc. Zool. Soc. Lond., 1893, pp. 717–718 [St. Vincent, W. I.].

*Male.*—General color yellow-brown, more fuscous on underside of thorax and hypopygium; legs banded and upper surface more or less variegated with dark-brown; mid and hind femora each with four dark bands and tibiae with 3, the latter also more or less darkened apically; front tibiae each with one pale band, and femora with two bands and some pale spots above; head and thorax with few and inconspicuous granulations; each succeeding division of thorax is shorter than that in front of it; abdomen widening gradually to juncture of fifth and sixth segments and narrowing as gradually to middle of seventh tergite posteriorly; the posterior angles of tergites 3–6 are slightly expanded laterally; tergite 7 is decidedly narrowed about the middle, transversely corrugated and broadly rounded apically, with a prominent median apiculation reaching about as far posteriorly as any part of hypopygium; hind margins of sternites 2–5 fairly straight, a little emarginate medianly, that of sixth decidedly so and arcuate laterally, of seventh and eighth on same plan as that of sixth but less pronounced; spiracle of eighth rather pedunculate; ninth sternite elongate, rather compressed posteriorly, with a strong anteriorly and almost horizontally directed apical hook; claspers obtriangular, broadened apically, the angles rounded (fig. 217).

*Female.*—Frontal spine and pronotal tubercles much smaller than in male, color of head, thorax, and legs paler, the dark markings merely indicated, abdomen more heavily maculated with fuscous; posterior angles of tergites 3–6 expanded laterally into rather prominent slightly backwardly directed teeth; tergites 4–6 each with a tubercle on median line near hind margin; seventh tergite almost parallel-sided, the hind angles but slightly concave, with a small median tubercle; eighth tergite about two-thirds as long as wide, transversely wrinkled and apiculate medianly; ninth tergite transversely corrugated, narrowed subapically, the margins raised, the disk depressed and smooth apically; hind margins of sternites 2–5 slightly emarginate medianly and sinuate laterally, of 6 deeply concave; seventh sternite nearly twice as long as sixth, the hind margin convex medianly, slightly concave laterally; eighth sternite barely visible from side.

Male, labelled St. Vincent Island, H. H. Smith. Length 17 millimeters.

Female, labelled Balthazar, Windward Side, Grenada, W. I., H. H. Smith. Length 18 millimeters.

The female from Grenada here described, with shorter pronotal tubercles, and with elevations on the hind margins of tergites 4–6, and other differences, may well be a species distinct from the true *angulata* of St. Vincent. However, settlement of this question may well await the availability of more material.

## APPENDIX 1.

### GENOTYPES OF THE FABRICIAN GENERA.

Certain authors claim that Fabricius indicated types of various hemipterous genera by repeating generic characters in the specific descriptions of the so-called genotypes. Much is made also of the fact that in most cases some of the phrases in these descriptions begin with italicized words.

In examining these claims it will be well to state the historical background of the case. Of the various early authors credited with the selection of genotypes in Hemiptera, Latreille (Considerations générales, etc., 1810) is the only one who asserts his definite intention (l'indication de l'espèce qui leur sert de type) and who consistently names only a single species to a genus. Lamarck and Laporte frequently cite more than one species to a genus and are only credited with fixing types when they happen to name just one illustration of a genus. Now it is clear that using the term in the modern sense these last two authors were not selecting genotypes. Because of *ex post facto* considerations we credit them with so doing when they accidentally mention but one species for a genus, but essentially we are putting a false construction on their work. Their system of citing illustrations of genera was followed by much later authors (as for instance Fieber, 1866); Stal who named more genera than any other hemipterist described many of them without any species, and never made a practice of naming genotypes; Reuter also still later paid little or no attention to type designation. In fact conscious selection of genotypes is a comparatively modern development in taxonomy and it is only in the most recent catalogues that an effort has been made to indicate definite type fixations for all the genera in large groups of insects.

In the light of these facts what probability is there that Fabricius in 1803 or earlier as in 1794 (as some authors claim) took action that we can consider as genotype fixation? The answer is there is no probability whatever that such was the case. Going further into the matter it should be said in this connection that the works of Fabricius have been viewed in an entirely different way than those of the other early authors. The latter are credited with type fixation only when they chanced to name a single species as an illustration of a genus or in connection with the description of a new genus. Fabricius had only one such instance in the Systema Rhyngotorum (1803), but in numerous cases he gave a preponderantly structural description of one of the species in a genus (not a repetition of the generic characters as has been stated) and in most of these instances he italicized the names of the different anatomical parts described. The statistics in the matter are: 45 genera are recognized in the Systema Rhyngotorum, of which 30 have species with special structural descriptions, and all but 2 of these have the italicized words. If Fabricius had been intentionally indicating genotypes it is highly probable he would have given all the genera uniform treatment; instead of only two-thirds of them. Further light can be had by tracing the matter back to the Entomologica Systematica (vol. 4, 1794). Kirkaldy finding some of the chiefly structural descriptions of species in that work logically accepted them as being as good indications of genotypes as those in the Systema Rhyngotorum. Other hemipterists do not agree with him, but the so-called type fixations in the earlier work stand or fall with those in the later, as they have exactly the same basis. In both works the descriptions in questions are merely more structural than others (compare genus *Membracis* for instance), and neither work gives them for all the genera. nor uniformly so far as italicization is concerned.

The four genotypes accepted by Kirkaldy from the earlier work are here listed with comment on their treatment in the later.

| 1794 | 1803 |
|---|---|
| 1. *Coreus scapha* | Given a much shorter though structural description. |
| 2. *Lygaeus valgus* | The structural description is transferred to *tenebrosus*. |
| 3. *Miris dolabratus* | No species has a structural description. |
| 4. *Gerris lacustris* | Species is transferred to Hydrometra retaining the structural description. |

Again we would repeat the question, Does this look like type fixation?, and again we answer, It does not. If Fabricius had been fixing genotypes he would not have altered his choice from a certain species in his earlier to another in the later work (2); after selecting a type in the former treatise he would not have left a genus entirely without one in the latter (3); nor would he have attempted to make the same species serve as type for two different genera (4).

It has been asserted that Fabricius somewhere has mentioned his intention of selecting genotypes, and that Fallén says he did, etc. We have examined the Philosophia Entomologica, 1778, and there is nothing in it to indicate that Fabricius had any conception of genotypes. He says nothing about selecting types in the Systema Rhyngotorum so the requirements of the International Code of Nomenclature, that type fixation must be definite, are not met. What Fabricius or any other author may have thought or said subsequent to publication has no effect on nomenclatorial practice.

## APPENDIX 2.

### SUMMARY OF GENERA AND SPECIES.

*Genera seen.*

| Genus synonyms indented. | Described species seen. | Described species not seen. | New species. | Total. |
|---|---|---|---|---|
| *Emesopsis* Uhler 1893 | 1 | | | 1 |
| *Empicoris* Wolff 1811 | 8 | | 4 | 12 |
| *Ploiariodes* White 1881. | | | | |
| *Ploiariola* Reuter 1888. | | | | |
| *Stenolemus* Signoret 1858 | 2 | 1 | 8 | 11 |
| *Phantasmatophanes* Kirkaldy 1908. | | | | |
| *Stenolemoides*, new subgenus. | | | | |
| *Deliastes* Dohrn 1863 | 1 | | 1 | 2 |
| *Panamia* Kirkaldy 1907 | 1 | | | 1 |
| *Lutevopsis* Champion 1898 | 1 | 1 | | 2 |
| *Emesa* Fabricius 1803 | 2 | 4 | 5 | 11 |
| *Westermannia* Dohrn 1860. | | | | |
| *Westermannias* Kirkaldy 1904. | | | | |
| *Myiagreutes* Bergroth 1911. | | | | |
| *Phasmatocoris* Breddin 1904. | | | | |
| *Rothbergia*, new subgenus. | | | | |
| *Polauchenia*, new genus | | | 2 | 2 |
| *Ploiaria* Scopoli 1786 | 8 | 6 | 14 | 28 |
| *Cerascopus* Heineken 1830. | | | | |
| *Emesodema* Spinola 1840. | | | | |
| *Luteva* Dohrn 1860. | | | | |
| *Ploiariopsis* Champion 1898. | | | | |
| *Gardena* Dohrn 1860 | 1 | | 11 | 12 |
| *Emesaya*, new name | 2 | 2 | [a] 7 | 11 |
| *Emesa* Authors. | | | | |
| *Metapterus* Costa 1860 | 4 | | 2 | 6 |
| *Barce* Stal 1865. | | | | |
| *Carambis* Stal 1866. | | | | |
| *Mantisoma* I͡akovlev 1874. | | | | |
| *Ghilianella* Spinola 1852 | 13 | 12 | 36 | 61 |
| *Ploeodonyx*, new subgenus. | | | | |
| *Lissonyx*, new subgenus. | | | | |
| Total | 44 | 26 | 90 | 160 |

[a] Three new subspecies also described.

*Genera not seen.*

| Genus. | Described species not seen. | Total. |
|---|---|---|
| *Emesella* Dohrn 1860 | 3 | 3 |
| *Malacopus* Stal 1862 | 1 | 1 |
| *Palacus* Dohrn 1863 | 2 | 2 |
| Total | 6 | 6 |

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Page numbers in boldface type indicate the principal account of the group concerned. Generic names in parentheses are those of combinations not valid in the sense of this paper.

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## PLATE 1.

FIG. 1. *Emesopsis nubila*, fore wing, 3 mm.[20]
2. *Empicoris rubromaculatus*, apex of abdomen of male from below. 0.25 mm.
3. *Empicoris vagabundus*, apex of fore wing. 2.25 mm.
4. *Empicoris orthoneuron*, fore wing, markings omitted. Apical notch possibly too pronounced. 2.75 mm.
5. *Empicoris orthoneuron*, male hypopygium from below. 0.2 mm.
6. *Empicoris winnemana*, apex of fore wing. 2 mm.
7. *Empicoris winnemana*, cross-veins of hind wing. 1 mm.
8. *Empicoris armatus*, apex of abdomen of male from below. 0.25 mm.
9. *Empicoris culiciformis*, same from side. 0.25 mm.
10. *Empicoris culiciformis*, hind wing. 2.75 mm.
11. *Empicoris errabundus*, fore wing. 3 mm.
12. *Empicoris errabundus*, apex of abdomen of male from below. 0.25 mm.
13. *Empicoris errabundus*, fore tibia and tarsus. 1 mm.
14. *Stenolemus arizonensis*, fore wing. 7 mm.
15. *Stenolemus arizonensis*, hind wing. 5.5 mm.
16. *Stenolemus arizonensis*, apex of abdomen of male from side. 0.75 mm.
17. *Stenolemus pristinus*, fore leg. Femur 1.8 mm.

S—Stigma; B—Basal discal cell; D—Discal cell.

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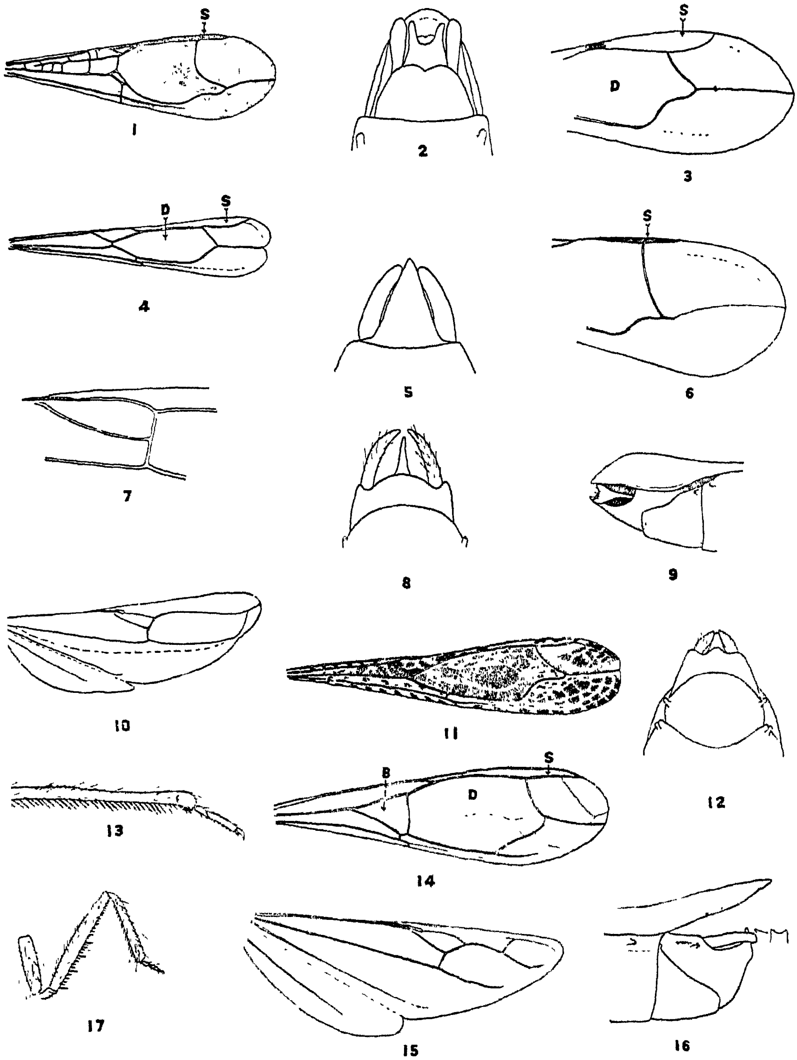
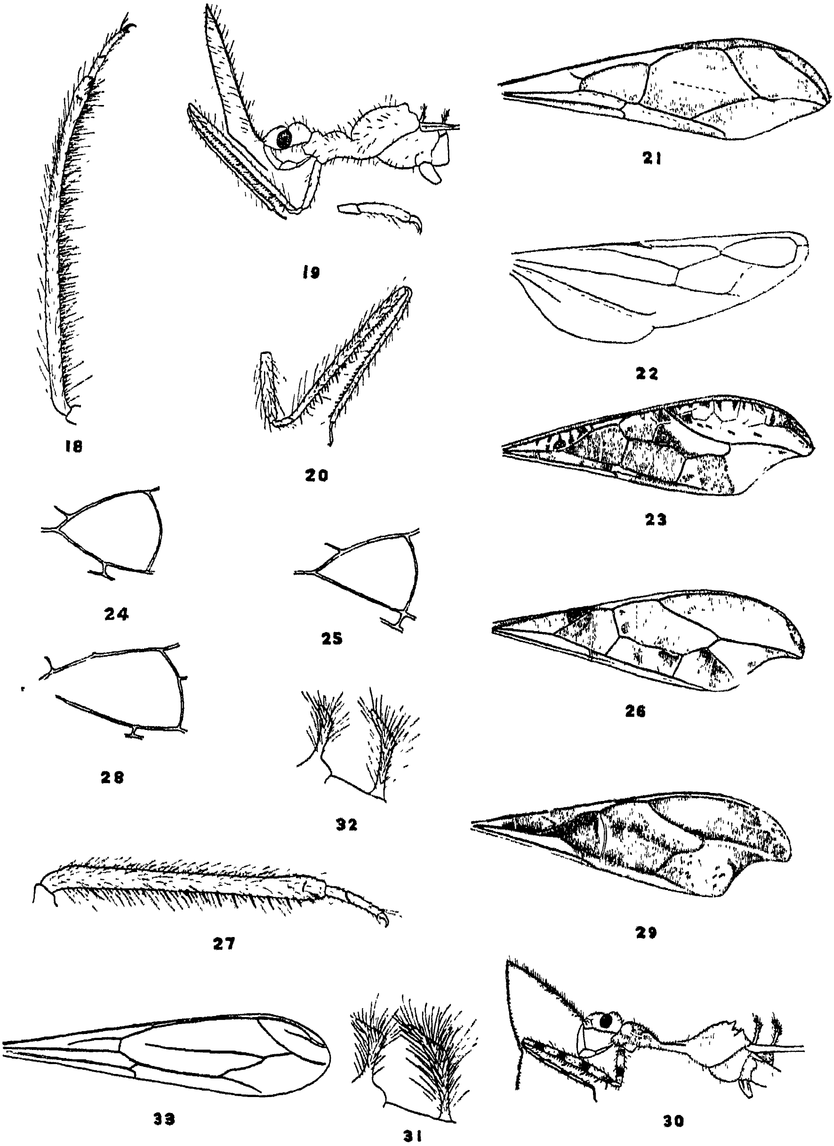
[20] Since the scale of the drawings varies, length in mm. is given in each case for the object shown or some definite part thereof.



STRUCTURAL DETAILS OF EMESOPSIS, EMPICORIS, AND STENOLEMUS

FOR EXPLANATION OF PLATE SEE PAGE 136



STRUCTURAL DETAILS OF STENOLEMUS AND MYIOPHANES

FOR EXPLANATION OF PLATE SEE PAGE 139

## PLATE 2.

FIG. 18. *Stenolemus arizonensis*, fore tibia and tarsus. 3.5 mm.

19. *Stenolemus pallidipennis*, profile of head and thorax. Length without antenna, head to end of pronotum 3 mm.
20. *Stenolemus pallidipennis*, fore leg. Femur 2 mm.
21. *Stenolemus pallidipennis*, fore wing. 7.5 mm.
22. *Stenolemus pallidipennis*, hind wing. 5.75 mm.
23. *Stenolemus schwarzi*, fore wing. 7 mm.
24. *Stenolemus variatus*, basal discal cell of fore wing. 1 mm.
25. *Stenolemus interstitialis*, same. 1 mm.
26. *Stenolemus hirtipes*, fore wing. 7 mm.
27. *Stenolemus hirtipes*, fore tibia and tarsus. 2 mm.
28. *Stenolemus mexicanus*, basal discal cell of fore wing. 1.2 mm.
29. *Stenolemus spiniger*, fore wing. 6.5 mm.
30. *Stenolemus spiniger*, profile of head and thorax. Length without antenna, head to end of pronotum. 3.5 mm.
31. *Stenolemus spiniger*, thoracic spines in profile. 0.75 mm.
32. *Stenolemus perplexus*, same. 0.75 mm.
33. *Myiophanes tipulina*, fore wing. 13 mm.

## PLATE 3.

FIG. 34. *Deliastes reticulatus*, fore wing. 6.75 mm.
35. *Deliastes reticulatus*, apex of male abdomen from behind. 1 mm.
36. *Deliastes reticulatus*, apex of abdomen of female from behind. 1 mm.
37. *Deliastes stramineipes*, process of hypopygium of male from behin
0.2 mm.
38. *Panamia ornata*, fore wing. 4.75 mm.
39. *Panamia ornata*, head from above. 0.5 mm.
40. *Panamia ornata*, apex of abdomen of male from side. 0.5 mm.
41. *Panamia ornata*, same from behind. 0.3 mm.
42. *Panamia ornata*, hind wing. 4.5 mm.
43. *Luteropsis longimanus*, fore wing. 5.5 mm.
44. *Luteropsis longimanus*, head from above. 1.1 mm.
45.[21] *Emesa annulatus*, fore wing.
46.[21] *Emesa mantis*, same.
47. *Emesa marmoratus*, same. 8 mm.
48.[21] *Emesa annulatus*, apex of abdomen of female from side.
49.[21] *Emesa annulatus*, same from behind.
50.[21] *Emesa mantis*, apex of abdomen of female from side.
51.[21] *Emesa mantis*, same, from behind.
52.[21] *Emesa mantis*, head and anterior part of prothorax from above.
53. *Emesa marmoratus*, hind wing. 7.5 mm.

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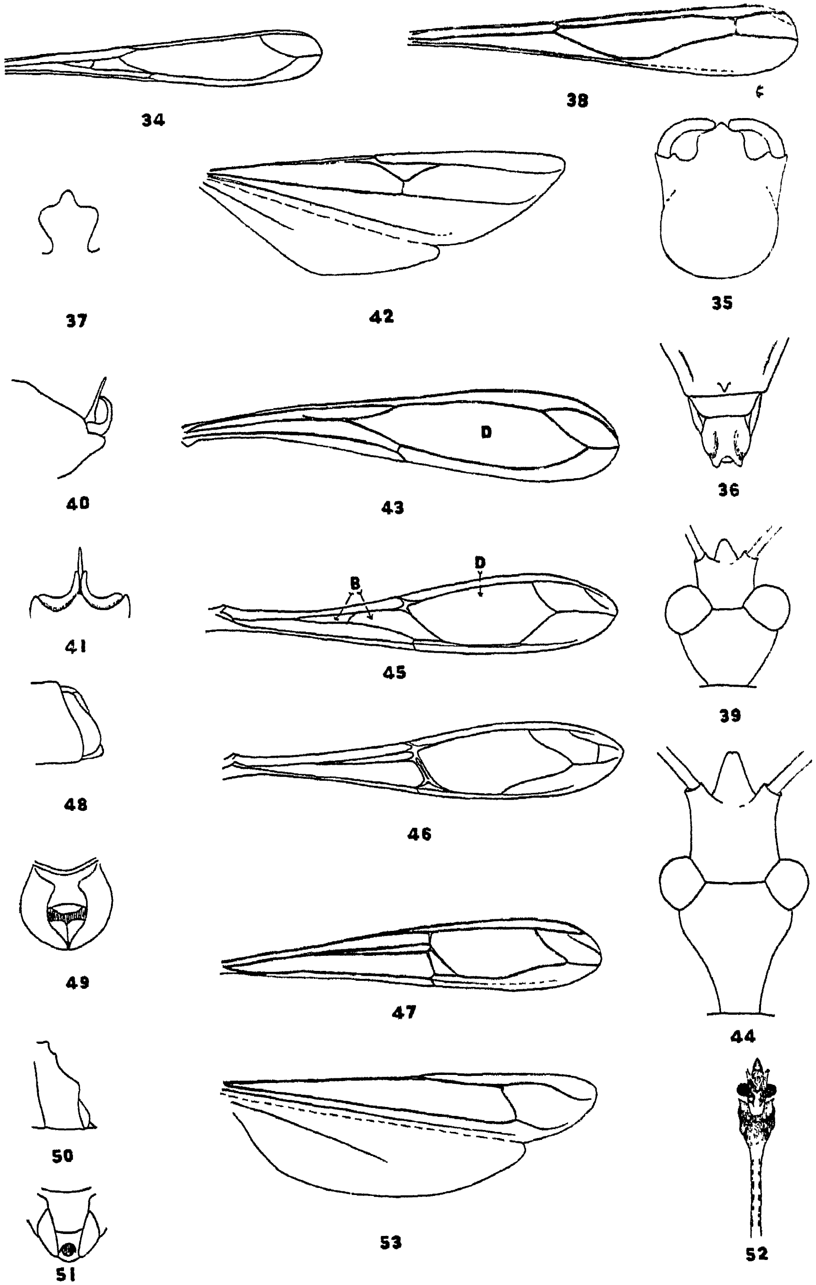
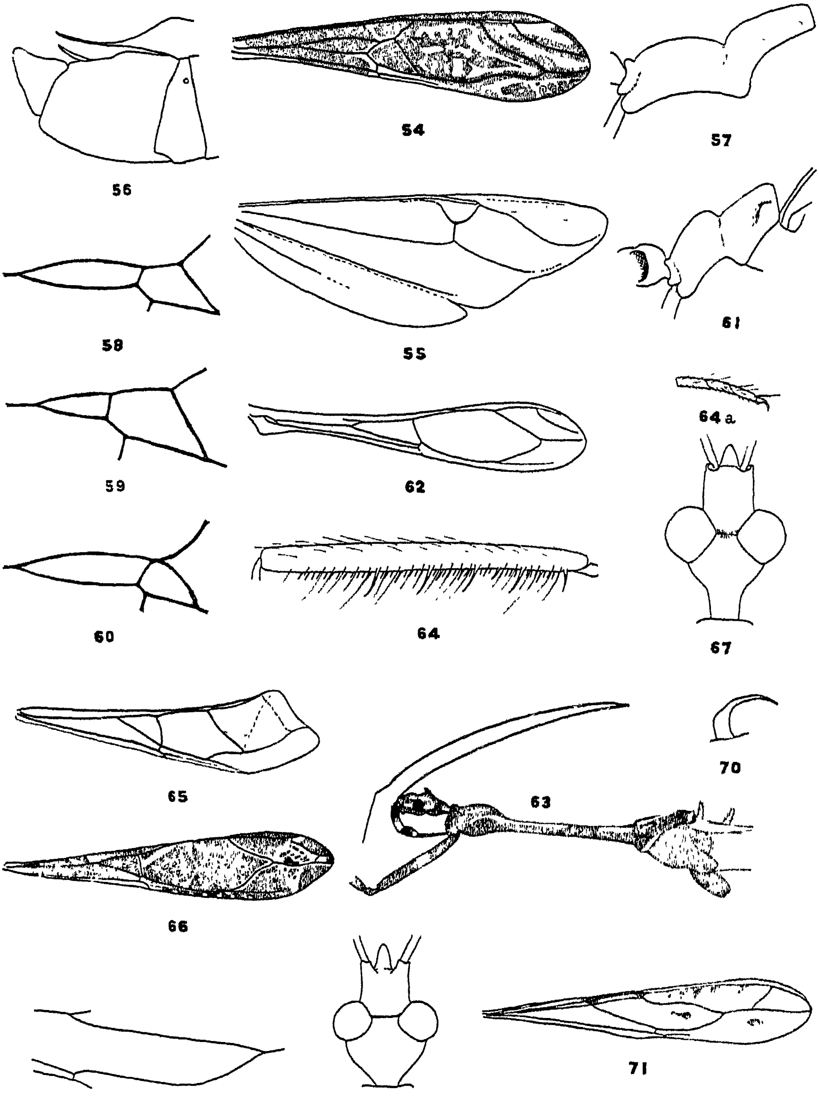
[21] Figs. 45, 46, 48, 49, 50, 51, 52, from sketches by W. E. China.



STRUCTURAL DETAILS OF DELIASTES, PANAMIA, LUTEVOPSIS, AND EMESA

FOR EXPLANATION OF PLATE SEE PAGE 140



STRUCTURAL DETAILS OF EMESA, POLAUCHENIA, AND PLOIARIA

FOR EXPLANATION OF PLATE SEE PAGE 143

## PLATE 4.

Fig. 54. *Emesa praecellens*, fore wing. 10.5 mm.

55. *Emesa praecellens*, hind wing. 9 mm.

56. *Emesa spectrum*, apex of abdomen of male from side. From type; not measured.

57. *Emesa rapax*, prothorax from side. 2.75 mm.

58. *Emesa rapax*, basal discal cell of fore wing. 2.5 mm.

59. *Emesa testaceus*, same. 1.9 mm.

60. *Emesa diffinis*, same. 1.5 mm.

61. *Emesa diffinis*, prothorax from side. 1.5 mm.

62. *Emesa? difficilis?*, fore wing, from sketch by W. E. China.

63. *Polauchenia protentor*, head and prothorax in profile. 6.75 mm.

64. *Polauchenia protentor*, fore femur. 4.5 mm.

64*a*. *Polauchenia protentor*, fore tarsus. 1.1 mm.

65. *Polauchenia protentor*, fore wing, markings omitted. 6 mm.

66. *Polauchenia biannulata*, fore wing. 10 mm.

67. *Ploiaria macrophthalma*, head from above. 1 mm.

68. *Ploiaria macrophthalma*, apex of discal cell of fore wing. 1.5 mm.

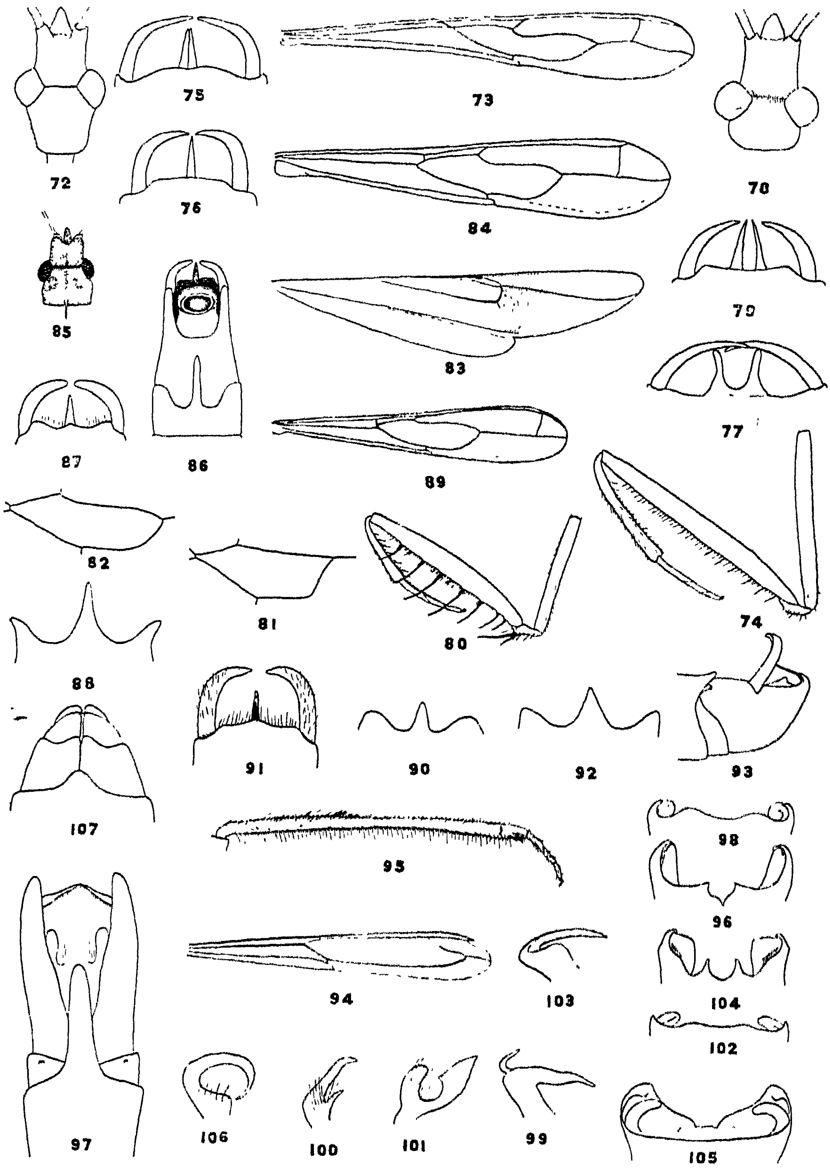
69. *Ploiaria brunnea*, head from above. 0.75 mm.

70. *Ploiaria sicaria*, right clasper of male hypopygium. 0.2 mm.

71. *Ploiaria setulifera*, fore wing. 5.5 mm.

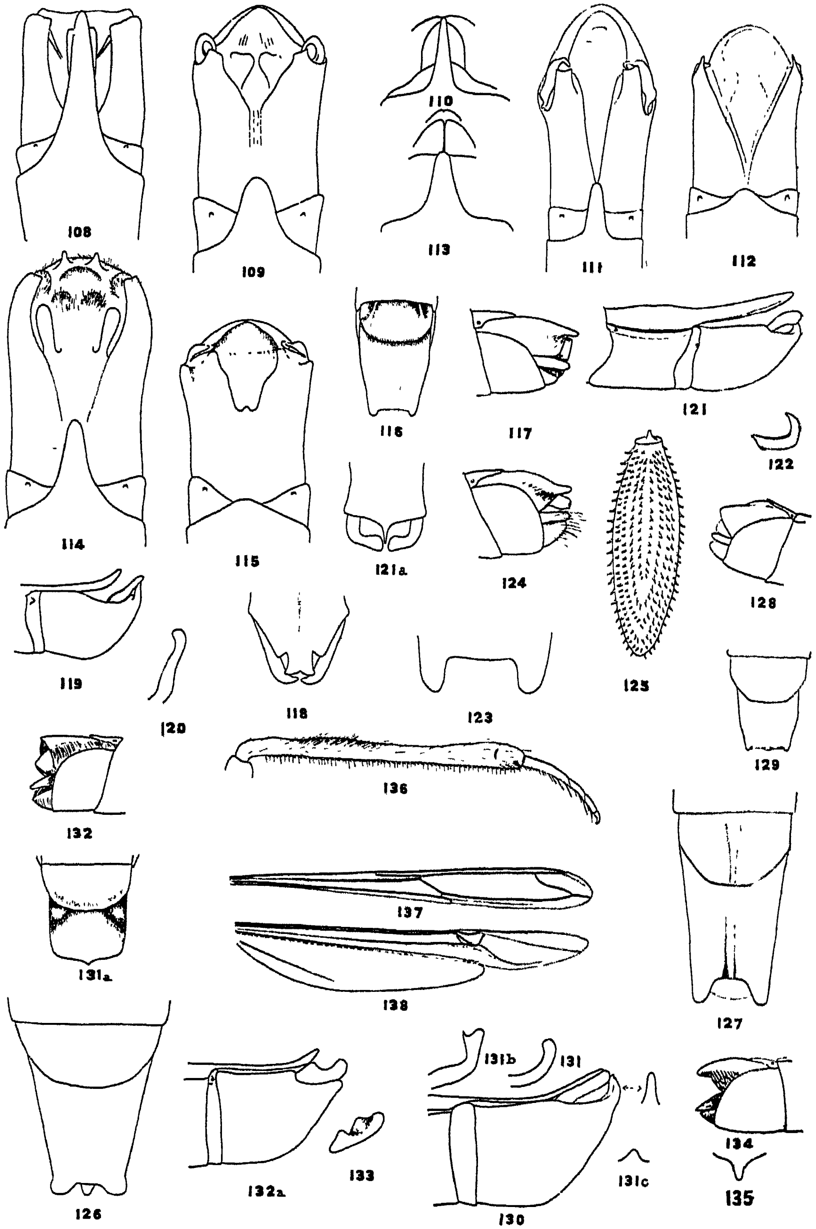
## PLATE 5.

Fig. 72. *Ploiaria gundlachi*, head from above. 0.8 mm.
73. *Ploiaria varipennis*, fore wing, markings omitted. 7 mm.
74. *Ploiaria varipennis*, fore leg. Femur 3.2 mm.
75. *Ploiaria carolina*, hypopygium male, hind margin. 0.33 mm. wide.
76. *Ploiaria floridana*, same. 0.3 mm. wide.
77. *Ploiaria bispina*, same. 0.25 mm. wide.
78. *Ploiaria pilicornis*, head from above. 0.66 mm.
79. *Ploiaria pilicornis*, male hypopygium, hind margin. 0.2 mm.
80. *Ploiaria uniseriata*, fore leg. Trochanter plus femur, 1 mm.
81. *Ploiaria uniseriata*, discal cell of fore wing. 1 mm.
82. *Ploiaria punctipes*, same. 1.2 mm.
83. *Ploiaria punctipes*, hind wing. 3.5 mm.
84. *Ploiaria similis*, fore wing. 5.9 mm.
85. *Ploiaria denticauda*, head from above. 0.66 mm.
86. *Ploiaria denticauda*, apex of abdomen of male from above, 0.66 mm.
87. *Ploiaria denticauda*, male hypopygium, hind margin, 0.2 mm.
88. *Ploiaria denticauda*, apical tergite of female. 0.33 mm. wide.
89. *Ploiaria denticauda*, fore wing. 4.25 mm.
90. *Ploiaria hirticornis*, apical tergite of female. 0.33 mm. wide.
91. *Ploiaria hirticornis*, male hypopygium, hind margin. 0.25 mm. wide.
92. *Ploiaria hirticornis*, apical tergite of male. 0.25 mm. wide.
93. *Ploiaria marginata*, male hypopygium. 0.6 mm.
94. *Gardena americana*, fore wing. 8 mm.
95. *Gardena americana*, for tibia and tarsus. 3.75 mm.
96. *Gardena americana*, hypopygium of male, hind margin. 0.75 mm.
97. *Gardena americana*, apex of abdomen of male from above. 1.25 mm.
98. *Gardena crispina*, male hypopygium, hind margin. 0.66 mm.
99. *Gardena eutropia*, hypopygial clasper of male. 0.2 mm.
100. *Gardena marcia*, same. 0.15 mm.
101. *Gardena pipara*, same. 0.15 mm.
102. *Gardena faustina*, male hypopygium, hind margin. 0.75 mm.
103. *Gardena faustina*, hypopygial clasper of male. 0.1 mm.
104. *Gardena poppaea*, male hypopygium, hind margin. 0.75 mm.
105. *Gardena domitia*, same. 0.8 mm.
106. *Gardena domitia*, hypopygial clasper of male. 0.1 mm.
107. *Gardena messalina*, apex of abdomen of female from below. 0.66 mm.



STRUCTURAL DETAILS OF PLOIARIA AND GARDENA

FOR EXPLANATION OF PLATE SEE PAGE 144



STRUCTURAL DETAILS OF GARDENA AND EMESAYA

FOR EXPLANATION OF PLATE SEE PAGE 146

## PLATE 6.

108. *Gardena crispina*, apex of abdomen of male from above. 1.25 mm.
109. *Gardena domitia*, same. 2 mm.
110. *Gardena domitia*, apex of abdomen of female from below. 0.33 mm.
111. *Gardena eutropia*, apex of abdomen of male from above. 2 mm.
112. *Gardena marcia*, same. 0.5 mm.
113. *Gardena caesonia*, apex of abdomen of female from below. 0.75 mm.
114. *Gardena poppaea*, apex of abdomen of male from above. 1.25 mm.
115. *Gardena faustina*, same. 1.25 mm.
116. *Emesaya banksi*, apex of abdomen of female from above. 1.1 mm.
117. *Emesaya banksi*, same from side. 1 mm.
118. *Emesaya incisa*, apex of abdomen of male from below. 0.5 mm.
119. *Emesaya incisa*, same from side. 1.25 mm.
120. *Emesaya incisa*, hypopygial clasper of male from above. 0.66 mm.
121. *Emesaya brevipennis*, apex of abdomen of male from side. 2.2 mm.
121*a*. *Emesaya brevipennis*, same from below. 0.75 mm. wide.
122. *Emesaya brevipennis*, hypopygial clasper of male from above. 0.5 mm.
123. *Emesaya brevipennis*, apex of apical tergite of female. 0.6 mm. wide.
124. *Emesaya brevipennis*, apex of abdomen of female from side. 1.25 mm.
125. *Emesaya brevipennis*, egg. 2.1 mm.
126. *Emesaya brevipennis*, *occidentalis*, apex of abdomen of female from above. 1.1 mm.
127. *Emesaya lineata*, same. 0.66 mm.
128. *Emesaya modica*, same from side. 0.5 mm.
129. *Emesaya modica*, same from above. 0.5 mm.
130. *Emesaya apiculata*, apex of abdomen of male from side. 1.6 mm.
131. *Emesaya apiculata*, hypopygial clasper of male. 0.5 mm.
131*a*. *Emesaya apiculata*, apex of abdomen of female from above. 0.8 mm.
131*b*.[22] *Emesaya precatoria*, male from above.
131*c*.[22] *Emesaya precatoria*, male hypopygial process from behind.
132. *Emesaya apiculata*, apex of abdomen of female from side. 0.8 mm.
132*a*. *Emesaya pollex*, apex of abdomen of male from side. 1.25 mm.
133. *Emesaya pollex*, hypopygial clasper of male. 0.2 mm.
134. *Emesaya pollex*, apex of abdomen of female from side. 1 mm.
135. *Emesaya pollex*, apex of last tergite of same from above. 0.2 mm.
136. *Emesaya brevipennis*, fore tibia and tarsus. 4 mm.
137. *Emesaya brevipennis*, fore wing. 10.5 mm.
138. *Emesaya brevipennis*, hind wing. 10 mm.

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[22] From sketches supplied by William Lundbeck.

## PLATE 7.

FIG. 139. *Metapterus fraterna*, head from side. 1.25 mm.

140. *Ischnonyctes*, species, head and prothorax in profile. 2.8 mm.

141. *Metapterus fraternus*, section of fore tarsus showing ventral armature. 0.33 mm.

142. *Metapterus fraternus*, fore wing. 6.5 mm.

143. *Metapterus fraternus*, hind wing. 6 mm.

144. *Ischnonyctes*, species, fore leg except coxa. Femur 3 mm.

145. *Metapterus annulipes*, fore tibia and tarsus. 1.9 mm.

146. *Metapterus uhleri*, fore leg except coxa. Femur 1.8 mm.

147. *Metapterus aberrans*, apex of abdomen of male from side. 1 mm.

148. *Metapterus uhleri*, apical tergite of female from above. 0.6 mm.

149. *Metapterus uhleri*, apex of abdomen of female from below. 1.2 mm.

150. *Metapterus uhleri*, apex of abdomen of male from side. 1 mm.

151. *Metapterus uhleri*, hypopygial hook and apices of claspers of male from rear, 0.2 mm.

152. *Metapterus neglectus*, male hypopygium from behind. 0.7 mm.

153. *Metapterus neglectus*, hypopygial hook from side. 0.2 mm.

154. *Metapterus neglectus*, apical tergite of female from above. 0.9 mm.

155. *Metapterus banksii*, male hypopygium from behind. 0.7 mm.

156. *Metapterus annulipes*, apex of abdomen of female from below. 1 mm.

157. *Metapterus annulipes*, apex of male abdomen from side. 2 mm.

158. *Metapterus annulipes*, hypopygial hook of male from behind. 0.15 mm. wide.

159. *Metapterus annulipes*, hypopygial clasper of male. 0.6 mm.

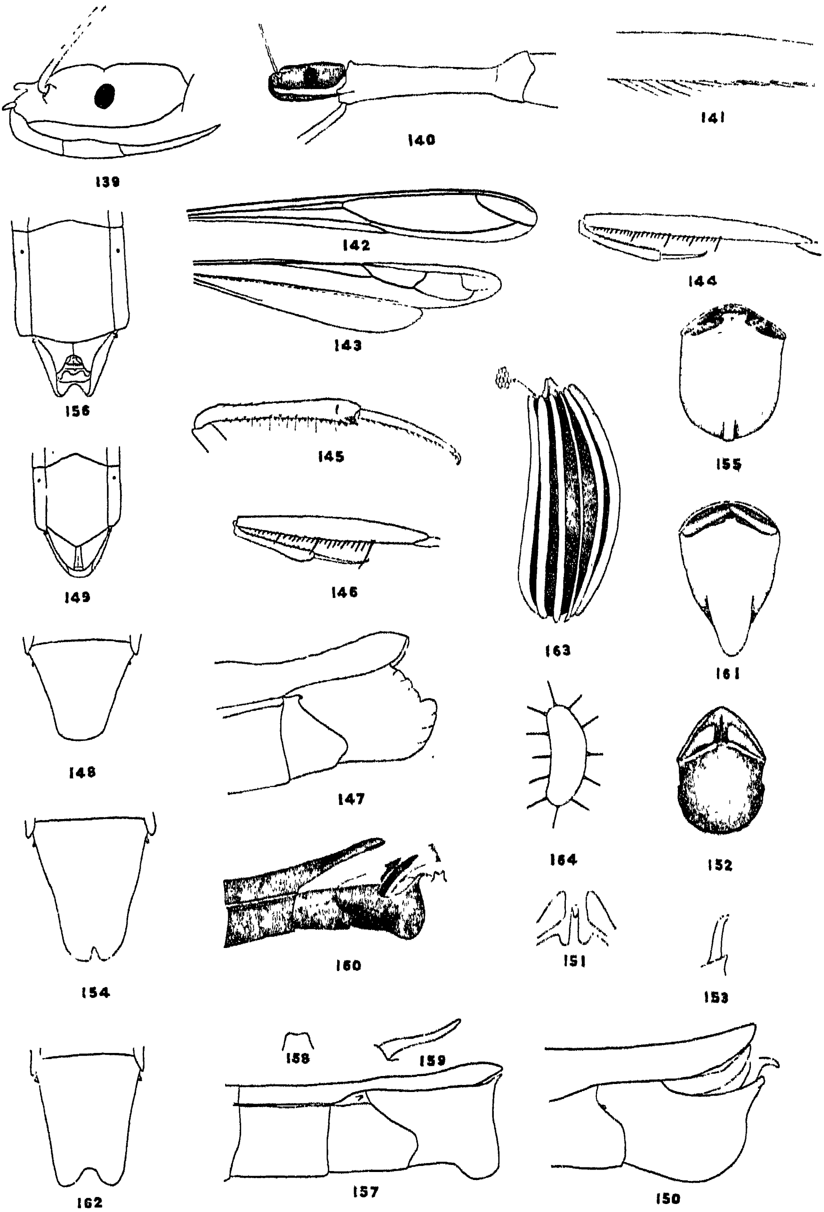
160. *Metapterus fraternus*, apex of abdomen of male from side. 1.8 mm.

161. *Metapterus fraternus*, hypopygium of male from behind. 0.8 mm.

162. *Metapterus fraternus*, apical tergite of female from above. 0.8 mm.

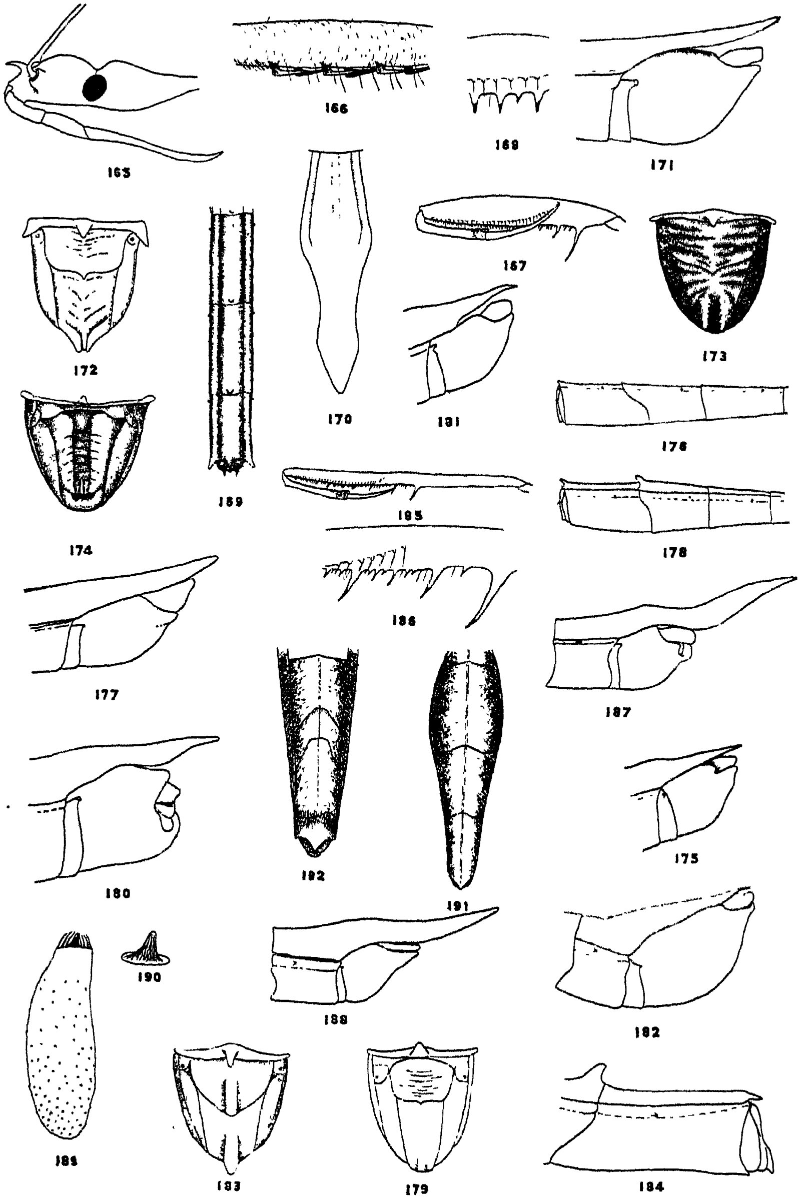
163. *Metapterus fraternus*, egg. 1 mm.

164. *Metapterus fraternus*, same, cross section. 0.3 mm.



STRUCTURAL DETAILS OF METAPTERUS AND ISCHNONYCTES

FOR EXPLANATION OF PLATE SEE PAGE 148



STRUCTURAL DETAILS OF GHILIANELLA

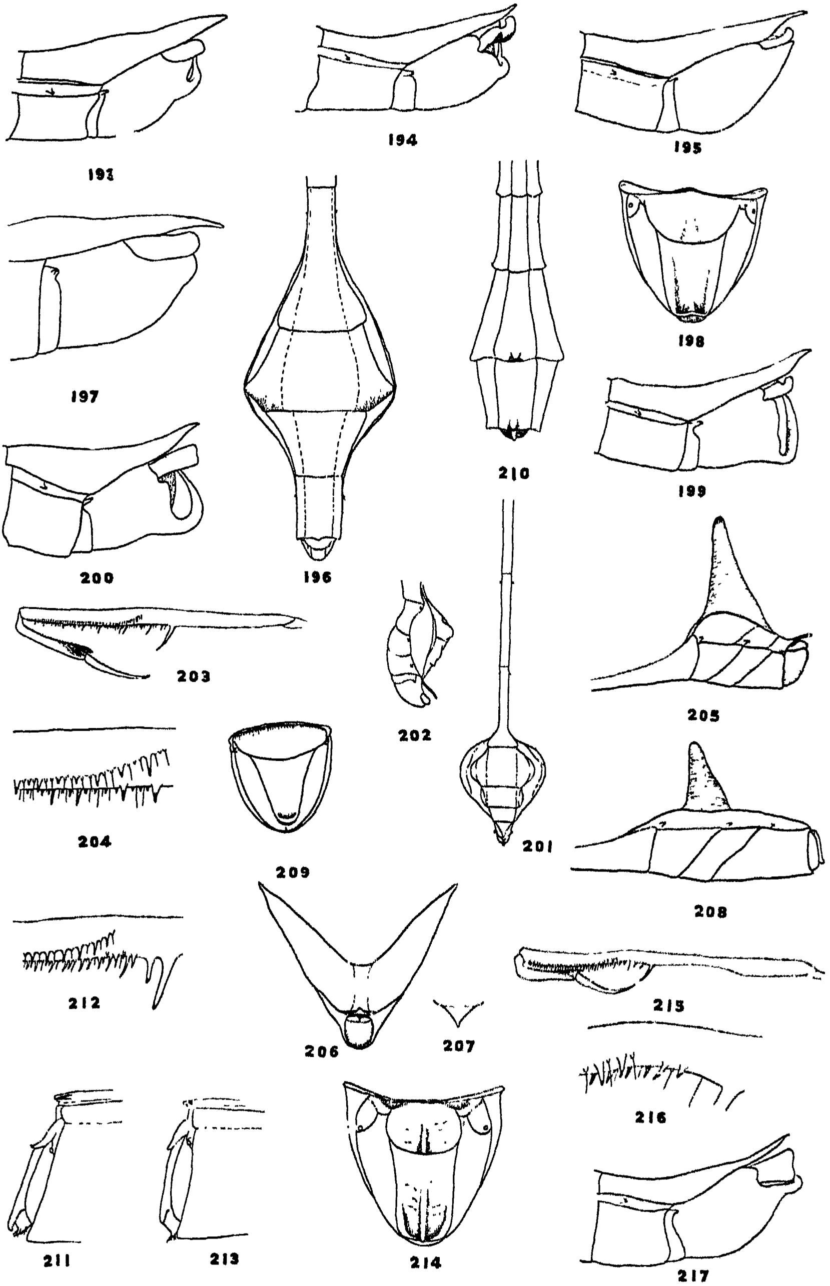
FOR EXPLANATION OF PLATE SEE PAGE 151

## PLATE 8.

FIG. 165. *Ghilianella*, species. Head in profile. About 2 mm.
166. *Ghilianella*, species. Section of fore tarsus showing ventral armature. About 0.3 mm.
167. *Ghilianella galapagensis*, fore leg except coxa. Femur 3.6 mm.
168. *Ghilianella galapagensis*, section of fore femur. About 0.2 mm.
169. *Ghilianella bicaudata*, apex of abdomen of female from above. 5.2 mm.
170. *Ghilianella persimilis*, apical tergite of male from above. 2.5 mm.
171. *Ghilianella persimilis*, apex of abdomen of male from side. 2 mm.
172. *Ghilianella persimilis*, apex of abdomen of female from behind. 0.8 mm.
173. *Ghilianella longula*, same. 1 mm.
174. *Ghilianella alveola*, same. 1 m.
175. *Ghilianella pascoei*, apex of abdomen of male from side. 1.25 mm.
176. *Ghilianella pascoei*, apex of abdomen of female from side. 4 mm.
177. *Ghilianella personata*, apex of abdomen of male from side. 2 mm.
178. *Ghilianella perversa*, apex of abdomen of female from side. 5.5 mm.
179. *Ghilianella perversa*, same from behind. 1.25 mm.
180. *Ghilianella apiculata*, apex of abdomen of male from side. 2. mm.
181. *Ghilianella pachitea*, same. 1.8 mm.
182. *Ghilianella aracataca*, same. 3 mm.
183. *Ghilianella aracataca*, apex of abdomen of female from behind. 1.1 mm.
184. *Ghilianella aracataca*, same from side. 2.25 mm.
185. *Ghilianella maculata*, fore leg except coxa. Femur 6.2 mm.
186. *Ghilianella maculata*, section of fore femur. 0.5 mm
187. *Ghilianella assa-nutrix*, apex of abdomen of male from side. 4.75 mm.
188. *Ghilianella gladiator*, apex of abdomen of male from side. 3 mm.
189. *Ghilianella gladiator*, egg. 1.6 mm.
190. *Ghilianella gladiator*, same, cap. 0.2 mm.
191. *Ghilianella stipititata*, abdomen of female from below. 6 mm.
192. *Ghilianella similata*, same. 4.75 mm.

## PLATE 9.

FIG. 193. *Ghilianella globulata*, apex of abdomen of male from side. 3.25 mm.
194. *Ghilianella patruela*, same. 3 mm.
195. *Ghilianella recondita*, same. 1.9 mm.
196. *Ghilianella recondita*, apical portion of abdomen of female from above. 6 mm.
197. *Ghilianella perigynium*, apex of abdomen of male from side. 1.5 mm.
198. *Ghilianella signata*, apex of abdomen of female from behind. 1.25 mm.
199. *Ghilianella strigata*, apex of abdomen of male from side. 2.25 mm.
200. *Ghilianella uncinata*, apex of abdomen of male from side. 2.5 mm.
201. *Ghilianella filiventris*, abdomen of male from above. 10 mm.
202. *Ghilianella filiventris*, apex of same from side. 3.5 mm.
203. *Ghilianella filiventris*, fore leg except coxa. Femur 5.5 mm.
204. *Ghilianella filiventris*, section of fore femur. 0.7 mm.
205. *Ghilianella mirabilis*, apex of abdomen of male from side. 6 mm. long, 5 mm. high.
206. *Ghilianella mirabilis*, same from behind. 5 mm. across points.
207. *Ghilianella mirabilis*, apical tergite of male from above. 0.8 mm.
208. *Ghilianella mirabilis*, apex of abdomen of female from side. 6 mm.
209. *Ghilianella mirabilis*, same from behind. 1 mm.
210. *Ghilianella annectens*, apex of abdomen of female from above. 6 mm.
211. *Ghilianella annectens*, same from side. 1.5 mm. high.
212. *Ghilianella annectens*, section of fore femur in front of basal spine. 1 mm.
213. *Ghilianella truncata*, apex of abdomen of female from side. 1.25 mm. high.
214. *Ghilianella truncata*, same from behind. 1.25 mm. high.
215. *Ghilianella insidiatrix*, fore leg except coxa. Femur 7 mm.
216. *Ghilianella insidiatrix*, section of fore femur. 1 mm.
217. *Ghilianella angulata*, apex of abdomen of male from side. 2 mm.



STRUCTURAL DETAILS OF GHILIANELLA

FOR EXPLANATION OF PLATE SEE PAGE 152

# NOTES ON THE METEORIC STONE OF COLBY, WISCONSIN

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By George P. Merrill

*Head Curator of Geology, United States National Museum*

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The stone described below was made the subject of a preliminary description[1] shortly after its fall by Prof. H. L. Ward, then director of the Public Museum of Milwaukee. Other data than those given were subsequently secured by Mr. Ward and an informal agreement entered into by which a joint descriptive paper was to be prepared by Mr. Ward and the present writer. Ill health and business matters on the part of the first named prevented the carrying out of this agreement and the matter has lain dormant—indeed was forgotten—until recently found while clearing up matters relating to my recent investigations under a grant from the National Academy of Sciences. As in the meantime the stone has been widely circulated, it would seem advisable to publish so much of the matter as pertains to my own studies, together with that which is essential from the first publication of Professor Ward.

The fall took place about 6.20 in the afternoon, July 4, 1917, within the corporate limits of Colby, Clark County, Wis. According to Professor Ward's original paper

> two pieces fell, the smaller about one half mile NNE, from the other. The larger stone (said to weigh 150 pounds) fell in a pasture, striking a granite rock, at least 2 inches in thickness, lying upon or near the surface, breaking this rock into many fragments and itself breaking into 27 or more pieces. The larger mass, weighing 22¾ pounds, penetrated the stiff Colby clay to a depth of 5 feet. Some of the smaller pieces are said to have distributed themselves in the soil to the extent of about 4 feet.
>
> The smaller stone fell in a cultivated field without breaking and is said to have penetrated the soil about 2 feet. This stone is variously described as about 10 by 14 by 3 or 4 inches, 17 or 18 inches by 9 by 9 inches and 21 by 11 by 11 inches at larger end, sloping in two directions to a wedge shape with rounded corners. This piece was said to be entirely covered with crust and to have weighed from 75 to 85 pounds.
>
> The man who extracted it from the earth informs me that it was so cold that frost immediately formed on its surface when exposed to the air.

---

[1] Science, vol. 46, Sept. 14, 1917.

Of the 75 or 85 pounds of material mentioned above, two pieces weighing, respectively, 1,686 and 1,956 grams, were received at the United States National Museum, and it is upon these that the following descriptive matter is based.

Macroscopically the stone is of a fine compact texture, sufficiently firm to take a polish, showing on a sawn surface an abundant sprinkling of small white and gray chondrules in part breaking with the matrix and but little metal, though it must be confessed that there is apparently more than indicated in the analysis quoted below. There are a number of sharp black veins along which a slight movement has taken place, producing slicken-sided or *hornischfläche* surfaces. They are plainly fractures due to crushing or some sudden shock, and not true veins.

Microscopic examination shows the silicate portion of the stone (91.415 per cent) to consist of olivine and enstatite, with small amounts of a maskelynite and more rarely the calcium phosphate merrillite. (See pl. 1.) There are also small black granules, assumed to be chromite. Troilite is rather abundant. An analysis made by Dr. J. E. Whitfield for the Milwaukee Museum, which I am permitted to use here, yielded:

| | |
|---|---|
| Mineral portion | 91.415 |
| Metallic portion<br>Iron nickel alloy | 0.995 |
| Troilite (FeS) | 7.590 |
| | 100.000 |

Composition of the mineral portion:

| | |
|---|---|
| Silica ($SiO_2$) | 45.280 |
| Alumina ($Al_2O_3$) | 3.103 |
| Chromic acid ($Cr_2O_3$) | 0.547 |
| Phosphoric acid ($P_2O_5$) | 0.284 |
| Ferrous oxide (FeO) | 16.484 |
| Manganese oxide (MnO) | 0.500 |
| Calcium oxide (CaO) | none |
| Magnesium oxide (MgO) | 32.166 |
| Nickel oxide (NiO) | 0.231 |
| Cobalt oxide (CoO) | 0.028 |
| Soda ($Na_2O$) | 1.218 |
| Potash ($K_2O$) | 0.158 |
| | 99.999 |

The composition of the metal alloy obtained by analysis of 0.4400 grams separated from accompanying troilite is as follows:

| | | Per cent |
|---|---|---|
| Iron | 0.4025= | 91.4777 |
| Nickel | 0.0338= | 7.682 |
| Cobalt | 0.0037= | 0.841 |

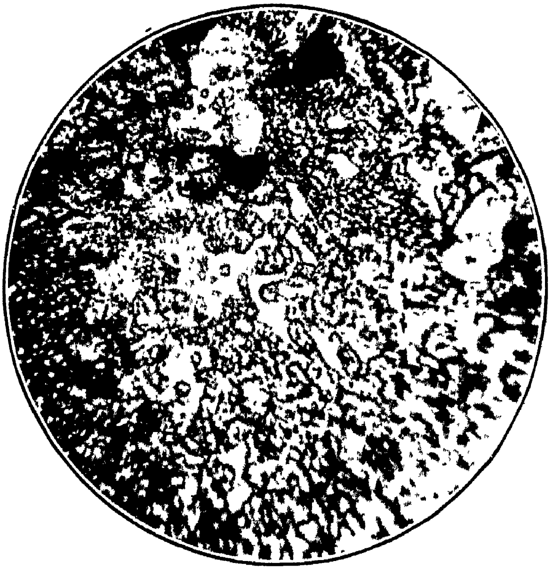
Recalculated, this gave the following totals:

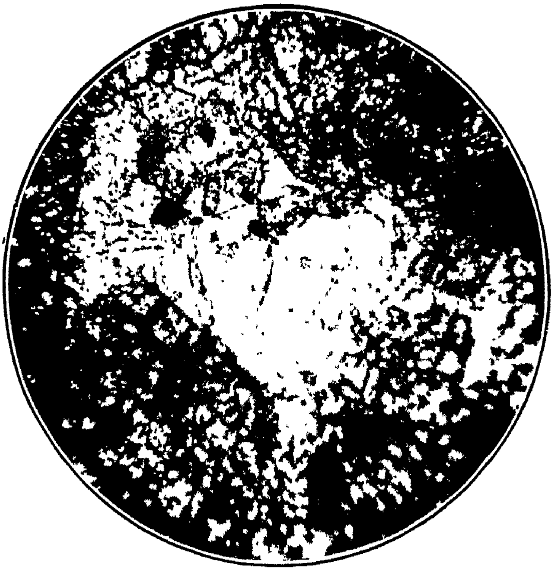
| | | |
|---|---|---|
| $SiO_2$ | 41.39 | Silicate portion. |
| $Al_2O_3$ | 2.83 | |
| $Cr_2O_3$ | 0.50 | |
| $P_2O_5$ | 0.25 | |
| FeO | 15.06 | |
| MnO | 0.45 | |
| CaO | none | |
| MgO | 29.40 | |
| NiO | 0.21 | |
| CoO | 0.02 | |
| $Na_2O$ | 1.11 | |
| $K_2O$ | 0.14 | |
| Fe | 0.90 | Metallic portion. |
| Ni | 0.07 | |
| Co | 0.02 | |
| Fe | 4.83 | Troilite. |
| S | 2.76 | |
| | 99.94 | |

Two features of the fall of this stone, as reported, are of unusual interest. (1,) The force of impact which was such as to fracture a piece of granite two inches in thickness and to penetrate the stiff clay—probably ground moraine—to a depth of five feet, and (2,) the temperature, which was so low that frost formed immediately upon its surface. In this respect the fall resembles that of Dhurmsala.

The statement made by Professor Ward that the stone was an achondrite is obviously an error, due either to a superficial examination or perhaps a typographical error. According to the prevailing method it should be classed as an intermediate chondrite.

○





METEORIC STONE FROM COLBY, WISCONSIN

FOR REFERENCE TO PLATE SEE PAGE 2

# STUDIES ON THE LARVAE OF CRABS OF THE FAMILY XANTHIDAE[1]

By O. W. Hyman

*Of the College of Medicine, University of Tennessee*

The larval stages of the Xanthidae are better known than those of any other family of the Brachyura. This doubtless is due to the fact that the adults habitually are found in shallow water near the shore and usually are very abundant. Ovigerous females may be taken without trouble, and thus the early zoeal stages may be known with certainty.

The family is well represented at Beaufort, N. C., and the writer is able to incorporate in these pages descriptions of the larvae of five genera based upon material collected there. Most of the known Xanthid larvae hatch with the prezoeal cuticle still intact. This is shed, however, within a few minutes. The first zoeal stage is characterized by the presence of dorsal, lateral, and rostral spines on the carapace and usually long and robust antennae.

The known zoeas of the family are separable into two groups. Those of *Panopeus* and *Xantho* have extremely minute exopodites on the antennae. Those of the remaining genera so far known have a well-developed exopodite. When arranged in a series, the zoea of *Panopeus* is found to be most highly specialized, while that of *Pilumnus* is least so.

The author is greatly indebted to Drs. Mary J. Rathbun and Waldo L. Schmitt of the United States National Museum for their generous aid in preparing the material of this paper for the press. The indebtedness of the author is also acknowledged to the United States Bureau of Fisheries for the use of the facilities of its Beaufort, N. C., station. The director, Mr. Charles Hatsel, has been of great assistance in collecting the material presented here.

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[1] This is the third of a series of studies on the larval stages of crabs. The first, Studies on larvae of crabs of the Family Pinnotheridae was published in the Proceedings of the U. S. National Museum (vol. 64, art. 7, pp. 1–9, pls. 1–6), and the second, Studies upon larvae of crabs of the Family Grapsidae, in the same serial, vol. 65, art. 10, pp. 1–8, pls. 1–2. A further study on the Development of Gelasimus [Uca] after hatching, is cited in the accompanying bibliography.

No. 2575.—Proceedings U. S. National Museum, Vol. 67, Art. 3

### KEY TO KNOWN ZOEAS

*a.*$^1$ Exopodite of antenna minute.
  *b.*$^1$ Distal third of antenna smooth............ **Neopanope texana sayi.**
  *b.*$^2$ Distal third of antenna hairy.
    *c.*$^1$ Antennule bearing pigment spot distally. **Eurypanopeus depressus.**
    *c.*$^2$ Antennule without pigment.
      *d.*$^1$ Third maxilliped distally bifurcated.......... **Xantho.**
      *d.*$^2$ Third maxilliped not distally bifurcated. **Panopeus herbstii.**
*a.*$^2$ Exopodite of antenna a distinct segment.
  *b.*$^1$ Antenna longer than rostral spine.................... **Pilumnus.**
  *b.*$^2$ Antenna shorter than rostral spine.
    *c.*$^1$ Tip of rostral spine hairy.......................... **Trapezia.**
    *c.*$^2$ Tip of rostral spine smooth.
      *d.*$^1$ Antenna one-half as long as rostral spine **Menippe mercenaria.**
      *d.*$^2$ Antenna two-thirds as long as rostral spine. **Eriphia spinifrons.**

### PIGMENTATION

Although the pigmentation of the zoeas of each species is a constant feature and is often of diagnostic value, the older papers do not describe it except in the most general terms. The following table is based upon the material collected at Beaufort. The pigment color varies from black to brown.

*Table showing position of chromatophores of zoeas*

| | *Neopanope* | *Eurypanopeus* | *Panopeus* | *Hexapanopeus* | *Menippe* |
|---|---|---|---|---|---|
| Anterior rostral | + | + | + | + | + |
| Interorbital | + | + | + | + | + |
| Supracardiac | + | + | + | + | + |
| Dorsal carapace spine | - | - | - | - | + |
| Lateral to first abdominal segment | - | - | - | - | - |
| Postero-ventral lobe | + | + | + | + | + |
| Labrum | - | - | - | - | + |
| Mandible | ++ | + | ++ | + | + |
| Antennule | - | + | - | - | - |
| Sternal | + | + | + | + | + |
| Base of antenna | - | - | - | - | + |
| Basipodite first maxilliped | ++ | ++ | + | + | + |
| Basipodite second maxilliped | ++ | ++ | + | ++ | + |
| Dorso-lateral first abdominal segment | + | + | + | + | + |
| Ventral firs tabdominal segment | - | - | - | - | - |
| Ventro-lateral second abdominal segment | + | + | + | + | + |
| Ventro-lateral third abdominal segment | + | + | + | + | + |
| Ventro-lateral fourth abdominal segment | + | + | + | + | + |
| Ventro-lateral fifth abdominal segment | + | + | + | + | + |
| Telson | + | + | + | + | + |

### METAMORPHOSIS

The complete larval history of *Neopanope* has been described while a nearly complete description has been given for *Xantho*, *Pilumnus*, and *Eriphia.* Only the prezoeal and first zoeal forms are known for the other genera.

In *Neopanope* the prezoea is followed by four zoeal stages and at least two megalops stages. The juvenile history of the crab stages has not been reported.

### NEOPANOPE TEXANA SAYI (Smith)

Plate 1, figs. 1, 3, 7, 11, 13, 17; plate 2, figs. 23, 27, 31; plates 3–8

The larval history of this species has been reported very fully by Birge. The writer has checked over the development on material secured at Beaufort, where the species is abundant. The following description varies from that of Birge in a number of details.

#### PREZOEA (fig. 1)

The larva hatches with the embryonic cuticle still intact. It is generally sluggish at first but becomes more active and—under laboratory conditions—sheds the cuticle in a few hours.

*Cephalothorax.*—The cuticle covering the cephalothorax is smooth and without processes, but the processes of the first zoeal stage may be seen folded beneath it. The dorsal spine is bent forward. It is telescoped upon itself and is quite wrinkled. The lateral spines are quite difficult to see but are present, folded against the side of the body. The rostral spine is wrinkled and telescoped like the dorsal spine. It is folded posteriorly and ventrally, lying between the bases of the appendages.

*Cephalic appendages.*—The antennular process (fig. 3) of the embryonic cuticle is greatly prolonged. It is bifurcated distally. One ramus is much longer and is sparsely hairy while the other is short, blunt, and smooth. The antennule of the first zoea extends out into the process, reaching to the point of bifurcation. At its tip it bears several sensory hairs that are partially invaginated.

The prezoeal antennal process (fig. 7) is also entirely different in shape from the zoeal antenna that it incloses. The prozoeal antenna is biramous. One ramus is a simple, smooth, blunt process into which the great spine of the zoeal antenna extends. The other ramus carries three sparsely hairy spines that are digitately arranged. A fourth spine is present as a minute, smooth process. The antenna of the zoea is seen within the cuticle. It is wrinkled and its distal two-thirds is telescoped on itself.

The mandibles (fig. 11), the maxillules (fig. 13), and the maxillae (fig. 17) are inclosed in simple sac-like prolongations of the cuticle. Each is typically brachyuran except that the hairs are invaginated.

*Thoracic appendages.*—Four pairs of thoracic appendages are recognizable, three pairs of maxillipeds and the chelipeds. Each is inclosed in a closely fitting, unsegmented sac of the embryonic cuticle. The first and second maxillipeds (figs. 23 and 27) are well developed. The endopodite of the first shows five segments and that of the second three. All of the hairs are invaginated. The third maxillipeds and the chelipeds appear as buds.

*Abdomen.*—The five segments and telson are clearly defined. The segments are closely invested by the embryonic cuticle, which is, however, not segmented. The cuticle covering the telson (fig. 31) is bifurcated. Each ramus bears seven large spines. Of these, the median three are sparsely hairy, elongated, and tapering. The middle spine is short, blunt, and smooth. Two of the lateral group are sparsely hairy and tapering, while the most lateral spine again is short and smooth. The zoeal telson nearly fills the cuticle. The tips of its cornua are invaginated. They extend out into the middle blunt spine. The hairs of the telson are only slightly invaginated. They extend out into the remaining spines.

### FIRST ZOEA (figs. 35 and 36)

After a few hours the embryonic cuticle is shed and the striking first zoea emerges. The elongated spines and antennae give the larva an awkward appearance, but it is quite active and swims well.

*Cephalothorax.*—Among the most striking features of the zoea are the dorsal and rostral spines. The dorsal spine rises from a slightly swollen base and sweeps upward and backward as a long, tapering process. It is almost straight. The rostral spine is longer and more slender than the dorsal. It extends ventrally and slightly anteriorly. The lateral spines are short and slender.

*Cephalic appendages.*—The antennae (fig. 59) are noteworthy. The spine is tremendously elongated, extending even beyond the rostral spine of the carapace. It is smooth to its tip. The minute exopodite is scarcely discernible where it is attached to the spine near its base. The other cephalic appendages are typical.

*Thoracic appendages.*—The first and second maxillipeds (figs. 63 and 67) show the usual four swimming hairs on the exopodites. The proximal segments of the endopodites are developed as masticating organs while the distal segments bear sensory hairs. The remaining thoracic appendages are discernible as minute buds.

*Abdomen.*—It is characteristic that the posterior lateral border of each segment is produced posteriorly as a spinous process. These are not very pronounced in this early stage. The cornua of the telson (fig. 72) are slender and greatly elongated. In addition to the usual three hairs on the median margin of each cornu, there are three minute spines placed laterally and dorsally.

### SECOND ZOEA (figs. 45 and 46)

According to Birge, the zoea molts a large number of times before it reaches the condition designated as the second zoeal stage. While my observations are not numerous enough to justify a dogmatic statement, I have not found this to be the case. Each of the first zoeas under my observation became transformed into a second-stage zoea at the first molt.

*Cephalothorax.*—The dorsal and rostral spines are longer and more slender. The eyes are movable.

*Cephalic appendages.*—The antennae (fig. 60) are longer and more slender. The maxillae (fig. 56) show changes in the scaphognathite, which is now a flattened plate with hairs along its border.

*Thoracic appendages.*—The number of swimming hairs on the first and second maxillipeds (figs. 64 and 68) is now six or seven. The third maxillipeds are larger and, at their distal ends, cleft into exopodite and endopodite. The chelipeds also show cleft extremities. The buds of the remaining pereiopods are easily identified.

*Abdomen.*—The lateral spinous processes on the segments are somewhat more pronounced. The anlagen of the abdominal appendages are visible beneath the cuticle but do not yet form protrusions. The cornua of the telson (fig. 73) are further elongated.

### THIRD ZOEA (figs. 47 and 49)

Again Birge states that several molts occur before the third zoeal stage is reached but my observations indicate that the second zoea becomes a third-stage zoea at the first molt.

While the earlier zoeas are taken in large numbers at the surface of the water, the third-stage form is rather rare. It is taken in small numbers both from the surface and from near the bottom. It doubtless has difficulty in maintaining itself at the surface on account of its increased weight.

*Cephalothorax.*—The dorsal and rostral spines are again longer and relatively more slender. The eyes are more freely movable and are relatively larger.

*Cephalic appendages.*—The antennules (fig. 39) are appreciably larger and are superficially constricted near the base. The antennae (fig. 61) are longer and more slender. Each shows now the anlage of the flagellum of the permanent antenna. This appears as a bud between the exopodite and the spine. The maxillule (fig. 53) shows a minute but significant change—a single epipodal hair appears on the basipodite.

*Thoracic appendages.*—The swimming hairs are now eight or nine. The exopodites of the first and second maxillipeds (figs. 65 and 69) show a sharp constriction indicating a division into two segments. The endopodite of the second maxilliped is significantly enlarged. The third maxillipeds and the remaining thoracic appendages are more prominent.

*Abdomen.*—The telson is now divided from the sixth abdominal segment. Each segment except the first shows a pair of buds—the abdominal appendages. The lateral spines on the third, fourth, and fifth segments are further prolonged. A fourth median spine appears on each cornu of the telson (fig. 74).

### FOURTH ZOEA (figs. 49 and 50)

The fourth and last zoea is larger and heavier and correspondingly clumsier. It is found most commonly on the bottom, where it swims spasmodically upward toward the light at intervals, but in the main is rolled along by the sweep of the tides.

*Cephalothorax.*—The body is now appreciably increased in weight while the spines are scarcely longer than in the previous stage.

*Cephalic appendages.*—The basal portion of the antennule (fig. 40) is now swollen and partially separated from the distal region by a deep constriction. The beginning of the statocyst appears in the swollen part. The tip of the antennule is divided into two rami. The inner ramus bears five or six sensory hairs; the outer is a short blunt bud. The flagellar bud of the antenna (fig. 63) is elongated. Its cuticle is not segmented but the internal fleshy part shows four or five segments distally. The mandible (fig. 44) now shows the anlage of its palp as a simple bud.

*Thoracic appendages.*—There are now twelve swimming hairs. The third maxilliped is well-developed although slender and weak in comparison with the first and second. Its exopodite carries a few hairs distally. Its endopodite shows indications of five segments. The pereiopods are large and, although they are short, all of their segments are clearly marked. A number of gill buds are distinguishable at this stage as follows: One on the third maxilliped, two on the cheliped, and one on each of the second and third pereiopods.

*Abdomen.*—The lateral spines and the cornua of the telson (fig. 75) now reach their maximum development. The buds of the abdominal appendages are elongated and cleft into exopodite and minute endopodite.

### MEGALOPS (figs. 76 and 77)

According to Birge, there are at least four molts during the megalops stage. The changes at each molt are slight, however. The megalops is an active and powerful swimmer. It occurs most commonly at the surface, but may be taken near the bottom. As its final molt approaches it seeks a crevice in some shell or stone near the tide line.

*Cephalothorax.*—An astonishing change in the form of the carapace occurs when the zoea changes to the megalops. The dorsal and lateral spines disappear completely. The frontal spine remains as a short, notched projection anteriorly. It is quite inconspicuous. The whole cephalothorax is now depressed rather than compressed.

*Cephalic appendages.*—The antennule (fig. 81) now acquires very nearly its permanent form. The basal part is composed of four large segments. The most proximal of these is swollen and contains the statocyst. The bud of the outer flagellum is elongated and separated from the basal segments by a joint. It carries a few hairs at its tip. The inner flagellum arises from the tip of the distal segment of the basal portion. It is composed of two or three segments, each bearing several hairs.

The antenna (fig. 83) now assumes practically the adult condition. It is composed of a basal portion of three large segments and a distal flagellum of about nine segments.

The mandible (fig. 85) is completely formed. Its palp shows three segments.

The maxillule (fig. 88) changes considerably. The two lobes of the basal portion become greatly elongated. The distal part loses its joint, becomes flattened, and is bent sharply outward.

The changes in the maxilla (fig. 91) are similar to those of the maxillule, although not so pronounced. The basal lobes are elongated and the distal part becomes a flattened plate bent slightly outward.

*Thoracic appendages.*—The maxillipeds all undergo profound changes. On the first maxilliped (fig. 94) there appears a large epipodite for the first time. The basipodite is produced into three or four lobes along its median margin and is much enlarged. The exopodite loses its joint, but is permanently flexed medially at that point. Its hairs are reduced to four or five and these are small. The endopodite loses its joints and becomes a flattened plate with few hairs. The appendage has lost its locomotor function and becomes an organ of mastication with, possibly, some sensory function.

The second maxilliped (fig. 97) is changed much like the first. Its epipodite appears. Its basipodite forms obscure median lobes, but is only slightly enlarged. The changes in the exopodite are like those in the first maxilliped but the retrogression is not so great. The endopodite becomes four-segmented and flattened.

The third maxilliped (fig. 100) is greatly enlarged, becoming the most robust of the three. It has a large epipodite. Its basipodite is scarcely larger. The exopodite is similar to that of the other two. The endopodite is composed of five segments and is greatly enlarged.

At the change to the megalops, the pereiopods acquire what is practically the adult condtion. Each appendage, however, is relative longer and more slender than in the adult. There is no difference between the right and left chelae.

*Abdomen.*—The whole abdomen becomes depressed. The telson is greatly changed. Its long cornua are lost and it becomes a simple plate with a rounded posterior border. The abdominal appendages (figs. 103 and 104) now become the chief organs of locomotion. In each the exopodite becomes flattened and carries long swimming hairs along its distal border. There are 18 such hairs on the appendage of the second segment and 6 on that of the sixth. The endopodite in each case is a small simple bud.

### FIRST CRAB (figs. 78 and 79)

After at least four molts, the megalops assumes the form of the first crab stage. The structural changes are not great. The animal now loses the power of swimming and crawls about near the tide line.

*Cephalathorax.*—The carapace is somewhat broadened. The last trace of the rostral spine is lost and the frontal margin of the carapace very closely resembles that of the adult. The eye is still a single segment and can not be erected.

*Cephalic appendages.*—The antennule assumes the adult condition. The external flagellum disappears and the internal becomes divided into six segments. The other cephalic appendages undergo very slight modifications.

*Thoracic appendages.*—The maxillipeds are very slightly changed. The most noticeable change is in the endopodite of the third. Its proximal two segments become enlarged to form an operculum for the mouthparts and the distal three segments appear as a palp.

*Abdomen.*—With the assumption of the crab form the abdomen undergoes a considerable change. It is further flattened and is permanently flexed under the sternum. Birge does not describe the abdominal appendages of the juvenile crab stages. Possibly the larval appendages of the megalops atrophy and are replaced by the permanent organs as in *Uca* (*Gelasimus*).[2]

## EURYPANOPEUS DEPRESSUS (Smith)

Plate 1, figs. 2, 4, 8, 14, 18; plate 2, figs. 24, 28, 32; plate 9

This species is not uncommon at Beaufort, but it is not so abundant as *Neopanope*. Its zoeas are frequently found in the tow and they may be distinguished from those of *Neopanope* at all stages, including the megalops, by the simple fact that all stages of the zoea and megalops of *Eurypanopeus* have a pigment spot on the antennule.

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[2] Hyman, 1920, p. 499; 1922, pp. 457, 458.

Birge mentions the first zoea of this species and gives certain characters by which it may be distinguished from *sayi*. I have studied only the prezoea and first zoea in detail, but have identifed the remaining zoea and megalops stages in specimens from the tow. Superficially, the development seems to be the same as in *sayi*. The characteristic differences between the first zoeal forms hold throughout.

### PREZOEA (fig. 2)

The prezoea is appreciably larger and more robust than that of *sayi*, but it agrees in structure except in certain details.

The prezoeal antennal cuticle (fig. 4) shows four large digitations on the lobe instead of three large ones and one minute one. The remaining appendages approximate those of *sayi* very closely, differing only relatively. In the telson (fig. 32) of *depressus* the spines of the prezoeal cuticle are longer than in *sayi*.

### FIRST ZOEA (figs. 106 and 107)

In general the zoea shows the features that characterize *sayi*. There are differences in detail, however, that make the zoeas more easily distinguishable than the adults.

*Cephalothorax.*—The dorsal and rostral spines are very long and slender. The dorsal spine is strongly hooked at its extremity.

*Cephalic appendages.*—The antennules are of the usual type, but each bears a large pigment spot distally (fig. 108). The antennae (fig. 109) are long and slender and gently curved. They bear bristles for nearly a third of their length distally.

There is nothing about the remaining appendages or the abdomen that would distinguish this species from *sayi*.

## PANOPEUS HERBSTII (Milne Edwards)

Plate 1, figs. 5, 9, 15, 19: plate 2, figs. 21, 25, 29, 33; plate 10

*Panopeus herbstii* is the most abundant Xanthid at Beaufort. It swarms under shells and débris all along the shores. I have studied the development up to the megalops stage, but only the prezoeal and first zoeal stages in detail. These resemble similar stages in *depressus* quite closely. The remaining zoeal stages develop as in *sayi*. The characteristics that distinguish the first zoea distinguish all subsequent zoeal stages.

### PREZOEA (fig. 21)

The prezoea is large, as in *depressus*, and is quite robust. The carapace is in an unusually immature condition, extending posteriorly hardly beyond the heart. The resemblances to the prezoea of *depressus* are so close that one would have great difficulty in distinguishing the two, except that in *herbstii* the antennule does not have a pigment spot.

### FIRST ZOEA (figs. 116 and 117)

The resemblance of the first zoea to that of *depressus* is very close. They may be distinguished by the absence of pigment on the antennule of *herbstii* and by several relative though pronounced differences.

The dorsal and rostral spines are slender as in *depressus* and the dorsal shows a terminal hook. However, both are distinctly shorter than in *depressus*. The antennae are shorter than in *depressus* and the exopodite is much larger.

The remaining appendages and the abdomen are like those of *depressus* except in minute details.

## HEXAPANOPEUS ANGUSTIFRONS (Benedict and Rathbun)

Plate 1, figs. 6, 10, 12, 16, 20; plate 2, figs. 22, 26, 30, 34

This species is rare at Beaufort. A single female was identified by Dr. W. P. Hay and presented to me in 1916. The eggs hatched but none of the prezoeas molted. None of the zoeal stages have been found in the tow.

### PREZOEA (fig. 22)

The prezoea resembles that of *sayi* quite closely in size and general appearance. It may be distinguished by details of structure. The lobe of the prezoeal cuticle of the antenna (fig. 6) has four large digitations instead of three. The telson (fig. 34) is bicornuate, but prezoeal cuticle of either ramus carries six hairs or processes instead of seven.

## Genus XANTHO

Plate 11; plate 12, figs. 141–151

The development of *Xantho* has been studied by Couch, Gourret, and Cano. Cano has given the most nearly complete description of its metamorphosis. He studied *X. rivulosus*, *X. floridus*, and *X. tuberculatus* but did not distinguish between the larval stages of the different species.

The zoeas of *Xantho* resemble those of *Neopanope* quite closely. They have the same type of carapace spines and of antennae.

### FIRST ZOEA (fig. 125)

*Cephalothorax.*—The rostral and dorsal spines are long and slender. The lateral spines are short and slender.

*Cephalic appendages.*—The antennules (fig. 138) have the typical conical form. The antennae (fig. 133) are as long as the rostral spine and are hairy along their distal two-thirds. The exopodite is minute. The remaining appendages are typical.

*Thoracic appendages.*—These are typical, except that the third maxilliped is unusually far advanced. Its bud already shows a distal bifurcation.

*Abdomen.*—The telson (fig. 150) is bicornuate. Each cornu bears three large spines medially, one minute hair dorsally, and two small hairs laterally.

### SECOND ZOEA

This stage has not been described. It seems to have been overlooked by Cano.

### THIRD ZOEA (figs. 126 and 127)

This stage is characterized by the increase in the number of swimming hairs to 9 or 10, and the presence of abdominal appendages as finger-shaped buds.

*Cephalothorax.*—The dorsal and rostral spines are still further elongated. The eye stalks are differentiated and the eyes are movable although the stalks can not be lifted from the orbits.

*Cephalic appendages.*—The antennule (fig. 126) shows a superficial differentiation into proximal and distal portions. The proximal portion is slightly enlarged. On the antenna (fig. 126) the anlage of the future flagellum appears as a finger-shaped bud between the exopodite and the spine.

*Thoracic appendages.*—The swimming hairs are now 9 or 10. The third maxilliped and the remaining thoracic appendages are long, finger-shaped buds and their points are indicated by superficial annulations.

*Abdomen.*—The telson is separated from the sixth abdominal segment by a joint. Each segment except the first bears a pair of finger-shaped buds—the abdominal appendages. The lateral spines on the third, fourth, and fifth segments are longer.

### FOURTH ZOEA (fig. 128)

In the last zoeal stage the body is increased in size and weight without a corresponding increase in the size of the carapace spine or the appendages.

*Cephalic appendages.*—The proximal portion of the antennule (fig. 134) is composed of two enlarged segments. The distal of these bears two rami, an inner of a single segment bearing sensory hairs and an outer that is a simple bud.

The flagellum of the antenna (fig. 134) is considerably elongated. The mandible (fig. 137) shows the bud of the future palp. The maxillule and the maxilla (fig. 142) reach their maximum differentiation.

*Thoracic appendages.*—There are now 11 or 12 swimming hairs. All of the thoracic appendages are developed and the segments of each are evident. Gill buds appear on the third maxilliped and the first and second pereiopods.

*Abdomen.*—The lateral spines of the third, fourth, and fifth segments are greatly elongated. The abdominal appendages are elongated and biramous.

### FIRST MEGALOPS (fig. 129)

After the molt from the last zoeal stage, the form of the carapace is almost completely changed. The dorsal and lateral spines are lost. The rostral spine has disappeared and two small frontal spines protrude from the anterior border of the carapace. The pereiopods are fully developed and the abdominal appendages are powerful swimming organs. The sense organs are all well developed in consonance with the more independent habits of the megalops.

*Cephalic appendages.*—The antennule (fig. 135) is now well formed. Its basal segment is greatly enlarged and contains the statocyst. Distally its two rami appear as short flagella that carry numerous sensory hairs.

The antenna (fig. 135) assumes what is practically the adult condition. The tremendous spine of the zoea disappears completely as does also the minute exopodite. The endopodite remains as a slender, many jointed flagellum that is sparsely hairy at the joints.

The mandible (fig. 138) also assumes the adult condition. The palp is divided into three segments, each of which bears a few hairs.

The maxillule (fig. 140 and the maxilla (fig. 143) begin to degenerate at this stage. Their endopodites begin to lose their joints and hairs.

*Thoracic appendages.*—The maxillipeds undergo a very striking transformation. They are no longer swimming organs, but are changed into masticatory appendages with sensory palps.

The first maxilliped (fig. 145) shows these typical changes. The exopodite becomes relatively smaller and permanently flexed near its middle. Its distal portion becomes a short flagellum and it carries several small hairs at its tip. The endopodite loses its joints and becomes adapted for mastication. The lobes of the basipodite are enlarged and adapted for mastication. A large epipodite is present.

The second maxilliped (fig. 146) has an exopodite like the first. The endopodite shows five segments. The basipodite carries a small epipodite and a gill bud.

The third maxilliped now becomes the largest of the three. Its exopodite is like that of the first and second. The endopodite is greatly enlarged and consists of six segments. The proximal three are large and flattened and form an operculum, while the distal three form a sensory palp. The basipodite carries an epipodite and two gills.

The pereiopods assume practically the adult condition (fig. 149). The cheliped shows the characteristic spine on the third segment.

*Abdomen.*—The abdomen is broadened and depressed. Each segment, beginning with the second, bears a well-developed appendage. Each typically consists of a proximal segment bearing a flattened exopodite and a minute endopodite. The exopodite carries long, plumose swimming hairs along its border. The hairs of the endopodite are small and curled inward as hooks. The appendages of the last segment do not have endopodites.

### SECOND MEGALOPS (fig. 130)

The second megalops stage differs only slightly from the first. The front of the carapace is altered and the whole carapace somewhat broadened in outline.

### FIRST CRAB (fig. 131)

The carapace is further depressed and its front is gently rounded. The outline of the carapace dorsally is almost circular. The appendages have undergone minor changes only.

## ERIPHIA SPINIFRONS (Herbst)

Plate 12, figs. 152–161

Cano has described the development of *Eriphia* and compared it with *Xantho*. The two show close agreement in many particulars, but *Eriphia* belongs with *Menippe*, *Trapezia*, and *Pilumnus* in having smaller antennae with well-developed exopodites.

### FIRST ZOEA (fig. 152)

The first zoea is sharply distinguished from those of *Panopeus* and *Xantho* by the relatively inconspicuous antenna. The dorsal spine is long and robust, as is also the rostral, although neither is as long as in the above-mentioned forms. The lateral spines are slender.

*Cephalic appendages.*—The antennule (fig. 155) is typical. The antenna (fig. 155) has a short spine that is hairy along its distal three-fourths. The spine is approximately half as long as the frontal spine of the carapace. The exopodite is composed of a single fingerlike segment that bears two or three hairs distally. It is two-thirds as long as the spine. The other cephalic appendages are typical.

*Thoracic appendages.*—These all have the typical brachyuran form.

*Abdomen.*—The telson (fig. 159) has three median spines and two minute lateral spines on each cornu.

### THIRD (SECOND?) ZOEA (fig. 153)

It is difficult to decide from Cano's description and figures whether his second zoeal stage should arise directly from his first or whether he has overlooked a stage between the two. Figure 153 seems to be that of a second zoea. There are only five abdominal segments. The pleopods are not protruding as is typically the case in the third zoea. The swimming hairs number six. On the other hand the antenna (fig. 156) shows the bud of the endopodite, a characteristic of the third zoeal stage, and the telson (fig. 160) shows four pairs of medial spines that also characterize the third zoea.

It may be that *Eriphia* has only three zoeal stages or it may be that Cano has failed to distinguish the second stage from the third and thus has described the appendages of the third stage as belonging to the second.

### FOURTH ZOEA (fig. 154)

The last zoeal stage described by Cano agrees very closely with the fourth zoeal stage of *Panopeus* and *Xantho*. The swimming hairs number 12 to 14. The endopodite of the antenna is elongated and the pleopods are elongated and biramous.

*Cephalic appendages.*—The antennule (fig. 157) shows a proximal portion composed of three enlarged segments. The first of these contains the developing statocyst. Distally the inner ramus of the antennule shows evidence of two or three joints, while the outer is a simple bud.

The endopodite of the antenna (fig. 157) is almost as long as the spine and shows the outlines of its future joints.

*Thoracic appendages.*—The pereiopods are all well formed and their gill buds are prominent. The first and second maxillipeds are the only thoracic appendages that are functional as yet however.

*Abdomen.*—The telson is now separated from the sixth abdominal segment by a joint. The pleopods are elongated and biramous, although none of them bear hairs as yet. The telson (fig. 161) has four pairs of median spines.

## MENIPPE MERCENARIA (Say)

### Plate 13

*Menippe mercenaria* is quite abundant at Beaufort and its zoeas are frequently taken in towing. However, only the prezoeal and first zoeal stages are known. *Menippe* differs from many other Brachyura in that its eggs do not always hatch at dusk or at night. They seem to hatch at any hour of day or night.

### PREZOEA (fig. 163)

The prezoea sheds its cuticle in a few minutes after leaving the egg. It differs from that of *Panopeus* in details only. The cuticle of the prezoeal antennule (fig. 164) shows two broad spines of unequal lengths. The antenna (fig. 165) terminates in a blunt point. It bears a lateral ramus near its tip that is prolonged into four subequal hairy digitations. The telson (fig. 166) carries seven spines on each cornu. The middle spine is short and smooth, the others long and hairy.

### FIRST ZOEA (figs. 167 and 168)

The zoea of *Menippe* differs strikingly from that of *Panopeus* and *Xantho*, but resembles that of *Eriphia* closely. The carapace spines are all robust. The antenna is scarcely as long as the rostral spine and its exopodite is as long as the antennal spine. The pigmentation along the anterior surface of the dorsal carapace spine is helpful in identifying this zoea.

*Cephalic appendages.*—The antennule (fig. 169) is simple and conical but it is longer than usual. The antenna (fig. 170) is comparatively small for a Xanthid. Its spine is slender and hairy along its distal portion. The exopodite is quite long and, with its terminal hairs, equals or exceeds the spine in length. The remaining cephalic appendages (figs. 171 and 172 and 173) have the typical brachyuran form.

*Thorax and abdomen.*—The thoracic appendages are typical (figs. 174 and 175). The fourth and fifth abdominal segments are characterized by short lateral spines that spring from their posterior borders. The telson (fig. 176) has the three pairs of median spines. In addition each cornu has a minute lateral spine and a minute dorsal spine.

## Genus TRAPEZIA

Plate 12, fig. 162

Spence Bate has described the first zoea of *Trapezia* very briefly and given one figure. The description is confined to the enumeration of the appendages present but other details may be learned from the figure.

The dorsal spine of the carapace is slender and is curved posteriorly. The rostral spine is short and covered with spines near its tip. The antenna is nearly as long as the rostral spine. The antennal spine is hairy near its tip. Its exopodite is nearly as long as its spine. The posterior borders of the third, fourth, and fifth abdominal segments are produced laterally into long, spinous processes.

## Genus PILUMNUS

Plate 14

Cano studied *Pilumnus hirtellus*, *P. villosus*, and *P. spinifer* but he did not distinguish between the species in his descriptions. Gourret states that the larvae of *P. spinifer* hatch at night but he does not describe them. Couch simply states that *P. hirtellus* hatches as a zoea. The following descriptions are based on Cano.

### FIRST ZOEA (fig. 177)

The zoea of *Pilumnus* is distinguished by its slender rostral spine and relatively large antenna. The buds of all the thoracic appendages are present and that of the third maxilliped is obviously biramous.

*Cephalic appendages.*—The antennule (fig. 183) has the usual conical form. The antenna (fig. 183) is nearly twice as long as the small rostral spine. The exopodite is as long as the antennal spine and bears a lateral hair near its tip. The remaining cephalic appendages are typical.

*Thoracic appendages and abdomen.*—The first and second maxillipeds are typical. The third maxilliped and the pereiopods are precociously developed. The buds are all large and that of the third maxilliped is biramous. The telson (fig. 192) has three median spines, two lateral spines—one very minute—and one dorsal spine on each cornu.

### SECOND ZOEA (fig. 178)

The second zoea shows the usual changes. There are six swimming hairs on each maxilliped. The gill buds have appeared on the thoracic appendages. Cano does not give a detailed description of the stage.

### THIRD ZOEA

Cano seems to have overlooked the third zoeal stage. His third stage apparently is the fourth zoea.

### FOURTH ZOEA (fig. 179)

The fourth zoea has ten to twelve swimming hairs, six abdominal segments, and biramous pleopods.

*Cephalic appendages.*—The antennule (fig. 184) now has a swollen basal segment for the statocyst. The inner of the two distal rami shows several constrictions and bears several sensory hairs; the outer is a simple bud. The antenna (fig. 184) shows an endopodite that nearly equals its spine in length.

*Thoracic appendages and abdomen.*—The third maxilliped and pereiopods are greatly enlarged and all their segments are differentiated. The pleopods, except that of the sixth segment, are bifurcated. The telson (fig. 193) is somewhat larger than in earlier stages but otherwise is not changed.

### FIRST MEGALOPS (fig. 180)

The rostral spine leaves a slight remnant. The thoracic appendages reach what is practically the adult condition. The abdominal appendages become the organs of locomotion, each appendage being equipped with numerous long swimming hairs.

*Cephalic appendages.*—These are typical for the megalops.

*Thoracic appendages.*—The first maxilliped is relatively smaller and its endopodite and exopodite are degenerated (fig. 186). It carries a large epipodite. The second maxilliped (fig. 188) is small. Its exopodite is degenerated and its exopodite has become a palp of five segments. It carries a small epipodite and a small gill bud. The third maxilliped (fig. 189) is quite large. Its endopodite is composed of six segments. It carries an epipodite and two gills. The cheliped (fig. 191) shows the typical spine on its third segment and has two gills on the coxopodite.

### SECOND MEGALOPS (fig. 182)

The carapace is further broadened and depressed. The frontal margin is broadened and somewhat bulbous. The abdomen is permanently flexed under the sternum.

The first maxilliped (fig. 187) is somewhat enlarged and has acquired its adult form. The third maxilliped (fig. 190) has reached its adult form. Both exopodite and endopodite terminate in palps. The proximal segments of the endopodite form an operculum for the other mouth parts.

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## EXPLANATION OF PLATES

### PLATE 1

FIG. 1. Prezoea, *Neopanope texana sayi.*
2. Prezoea, *Eurypanopeus depressus.*
3. Antennule, *Neopanope texana sayi.*
4. Antennule, *Eurypanopeus depressus.*
5. Antennule, *Panopeus herbstii.*
6. Antennule, *Hexapanopeus angustifrons.*
7. Antenna, *Neopanope texana sayi.*
8. Antenna, *Eurypanopeus depressus.*
9. Antenna, *Panopeus herbstii.*
10. Antenna, *Hexapanopeus angustifrons.*
11. Mandible, *Neopanope texana sayi.*
12. Mandible, *Hexapanopeus angustifrons.*
13. Maxillule, *Neopanope texana sayi.*
14. Maxillule, *Eurypanopeus depressus.*
15. Maxillule, *Panopeus herbstii.*
16. Maxillule, *Hexapanopeus angustifrons.*
17. Maxilla, *Neopanope texana sayi.*
18. Maxilla, *Eurypanopeus depressus.*
19. Maxilla, *Panopeus herbstii.*
20. Maxilla, *Hexapanopeus angustifrons.*

### PLATE 2

FIG. 21. Prezoea, *Panopeus herbstii.*
22. Prezoea, *Hexapanopeus angustifrons.*
23. First maxilliped, *Neopanope texana sayi.*
24. First maxilliped, *Eurypanopeus depressus.*
25. First maxilliped, *Panopeus herbstii.*
26. First maxilliped, *Hexapanopeus angustifrons.*
27. Second maxilliped, *Neopanope texana sayi.*
28. Second maxilliped, *Eurypanopeus depressus.*
29. Second maxilliped, *Panopeus herbstii.*
30. Second maxilliped, *Hexapanopeus angustifrons.*
31. Telson, *Neopanope texana sayi.*
32. Telson, *Eurypanopeus depressus.*
33. Telson, *Panopeus herbstii.*
34. Telson, *Hexapanopeus angustifrons.*

### PLATE 3

*Neopanope texana sayi*

FIG. 35. First zoea, frontal view.
36. First zoea, lateral view.
37. Antennule, first zoea.
38. Antennule, second zoea.
39. Antennule, third zoea.
40. Antennule, fourth zoea.
41. Mandible, first zoea.
42. Mandible, second zoea.
43. Mandible, third zoea.
44. Mandible, fourth zoea.

### PLATE 4

*Neopanope texana sayi*

FIG. 45. Second zoea, frontal view.
46. Second zoea, lateral view.
47. Third zoea, lateral view.
48. Third zoea, frontal view.

### PLATE 5

*Neopanope texana sayi*

FIG. 49. Fourth zoea, frontal view.
50. Fourth zoea, lateral view.
51. Maxillule, first zoea.
52. Maxillule, second zoea.
53. Maxillule, third zoea.
54. Maxillule, fourth zoea.
55. Maxilla, first zoea.
56. Maxilla, second zoea.
57. Maxilla, third zoea.
58. Maxilla, fourth zoea.

### PLATE 6

*Neopanope texana sayi*

FIG. 59. Antenna, first zoea.
60. Antenna, second zoea.
61. Antenna, third zoea.
62. Antenna, fourth zoea.
63. First maxilliped, first zoea.
64. First maxilliped, second zoea.
65. First maxilliped, third zoea.
66. First maxilliped, fourth zoea.

### PLATE 7

*Neopanope texana sayi*

FIG. 67. Second maxilliped, first zoea.
68. Second maxilliped, second zoea.
69. Second maxilliped, third zoea.
70. Second maxilliped, fourth zoea.
71. Pleopod, fourth zoea.
72. Telson, first zoea.
73. Telson, second zoea.
74. Telson, third zoea.
75. Telson, fourth zoea.

### PLATE 8

*Neopanope texana sayi* (after Birge)

FIG. 76. First megalops, lateral view.
77. First megalops, dorsal view.
78. Carapace of first crab stage, dorsal view.
79. Carapace of first crab stage, ventral view.

FIG. 80. Carapace of adult crab, dorsal view.
81. Antennule, first megalops.
82. Antennule, adult.
83. Antenna, first megalops.
84. Antenna, adult megalops.
85. Mandible, first megalops.
86. Mandible, late megalops.
87. Mandible, adult.
88. Maxillule, first megalops.
89. Maxillule, first crab.
90. Maxillule, adult.
91. Maxilla, first megalops.
92. Maxilla, young crab.
93. Maxilla, adult.
94. First maxilliped, first megalops.
95. First maxilliped, first crab.
96. First maxilliped, adult.
97. Second maxilliped, first megalops.
98. Second maxilliped, first crab.
99. Second maxilliped, adult.
100. Third maxilliped, first megalops.
101. Third maxilliped, first crab.
102. Third maxilliped, adult.
103. Last pleopod, first megalops.
104. Third pleopod, first megalops.
105. Third pleopod, adult.

## PLATE 9

*Eurypanopeus depressus*, first zoea

FIG. 106. First zoea, lateral view.
107. First zoea, frontal view.
108. Antennule.
109. Antenna.
110. Mandibles.
111. Maxillule.
112. Maxilla.
113. First maxilliped.
114. Second maxilliped.
115. Telson.

## PLATE 10

*Panopeus herbstii*, first zoea

FIG. 116. First zoea, lateral view.
117. First zoea, frontal view.
118. Antennule.
119. Antenna.
120. Maxillule.
121. Maxilla.
122. First maxilliped.
123. Second maxilliped.
124. Telson.

## PLATE 11

### *Xantho* (after Cano)

FIG. 125. First zoea, lateral view.
126. Third zoea, frontal view.
127. Third zoea, lateral view.
128. Fourth zoea, lateral view.
129. First megalops.
130. Second megalops.
131. First crab.
132. Older crab.
133. Antennule and antenna, first zoea.
134. Antennule and antenna, fourth zoea.
135. Antennule and antenna, first megalops.
136. Mandible, first zoea.
137. Mandible, fourth zoea.
138. Mandible, first megalops.
139. Maxillule, first zoea.
140. Maxillule, first megalops.

## PLATE 12

### *Xantho* (after Cano)

FIG. 141. Maxilla, first zoea.
142. Maxilla, fourth zoea.
143. Maxilla, first megalops.
144. Thoracic appendages, fourth zoea.
145. First maxilliped, first megalops.
146. Second maxilliped, first megalops.
147. Third maxilliped, first megalops.
148. Third maxilliped, first crab.
149. Cheliped, first megalops.
150. Telson, first zoea.
151. Telson, fourth zoea.

### *Eriphia spinifrons* (after Cano)

FIG. 152. First zoea.
153. Second zoea.
154. Fourth zoea.
155. Antennule and antenna, first zoea.
156. Antennule and antenna, second zoea.
157. Antennule and antenna, fourth zoea.
158. Mandible, fourth zoea.
159. Telson, first zoea.
160. Telson, second zoea.
161. Telson, fourth zoea.

### *Trapezia* (after Spence Bate)

FIG. 162. First zoea.

## PLATE 13

### *Menippe mercenaria*

#### Prezoea

FIG. 163. Prezoea.
164. Antennule.
165. Antenna.
166. Telson.

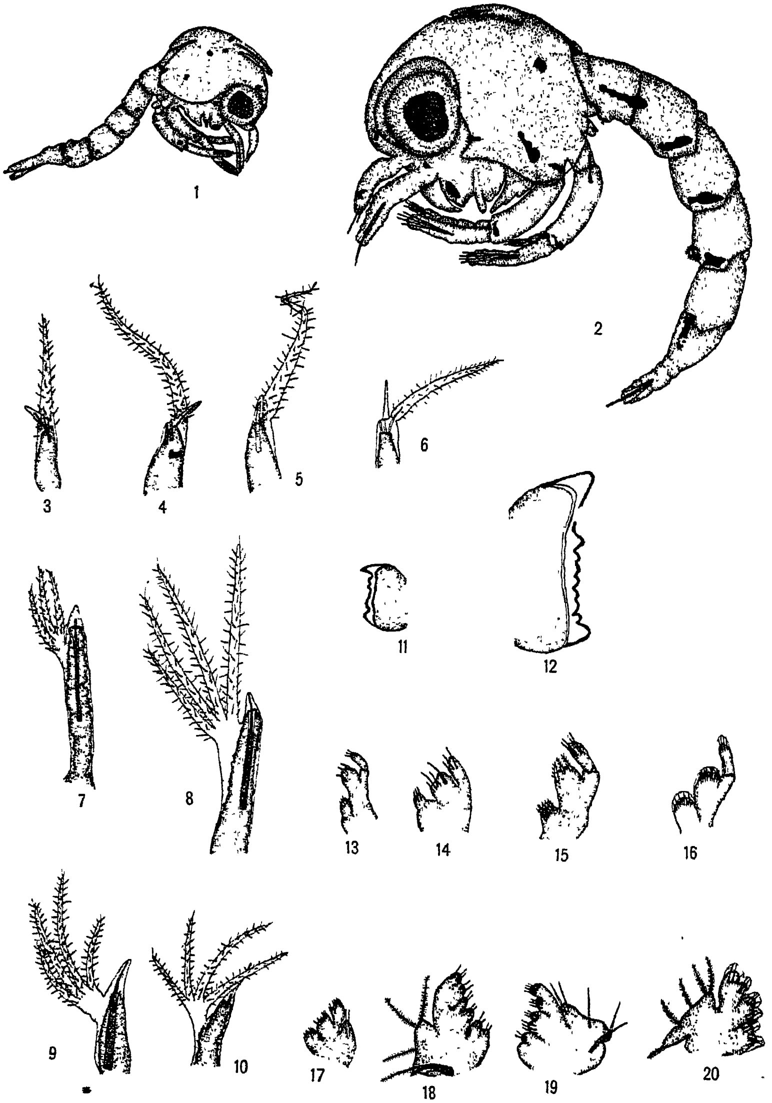
#### First zoea

FIG. 167. First zoea, frontal view.
168. First zoea, lateral view.
169. Antennule.
170. Antenna.
171. Mandible.
172. Maxillule.
173. Maxilla.
174. First maxilliped.
175. Second maxilliped.
176. Telson.

## PLATE 14

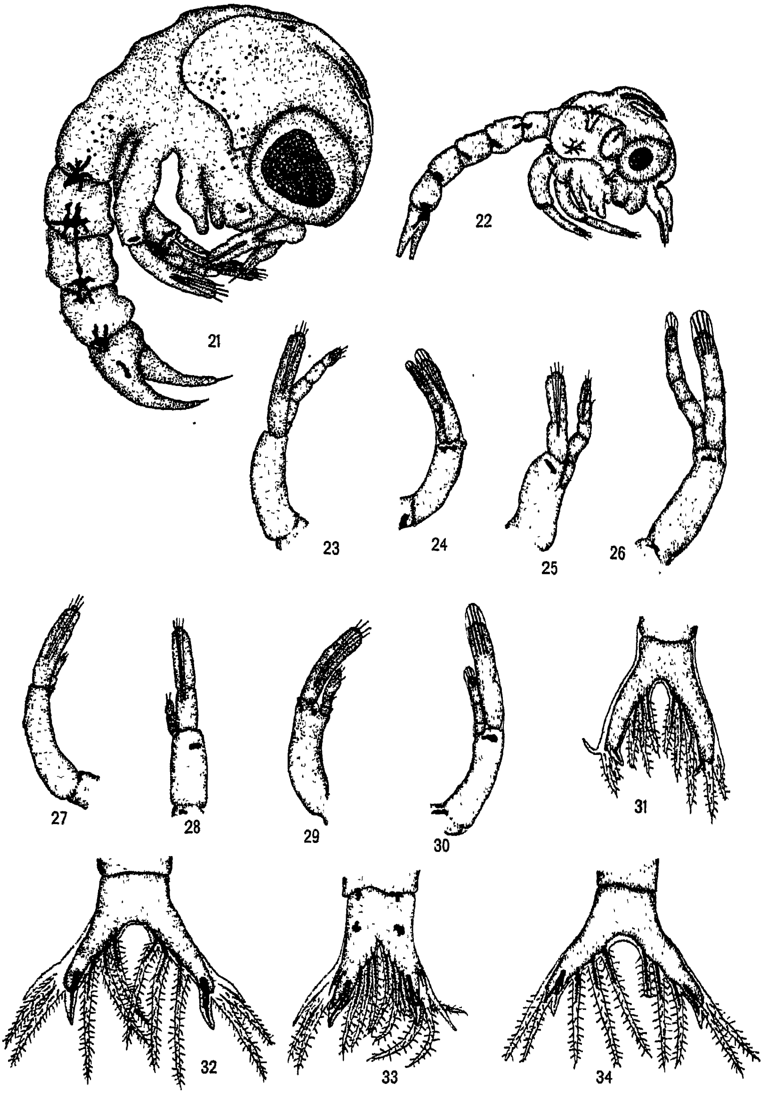
### *Pilumnus* (after Cano)

FIG. 177. First zoea.
178. Second zoea.
179. Fourth zoea.
180. First megalops.
181. Second megalops.
182. First crab.
183. Antennule and antenna, first zoea.
184. Antennule and antenna, fourth zoea.
185. Mandible, first zoea.
186. First maxilliped, first megalops.
187. First maxilliped, first crab.
188. Second maxilliped, first megalops.
189. Third maxilliped, first megalops.
190. Third maxilliped, first crab.
191. Cheliped, first megalops.
192. Telson, first zoea.
193. Telson, fourth zoea.



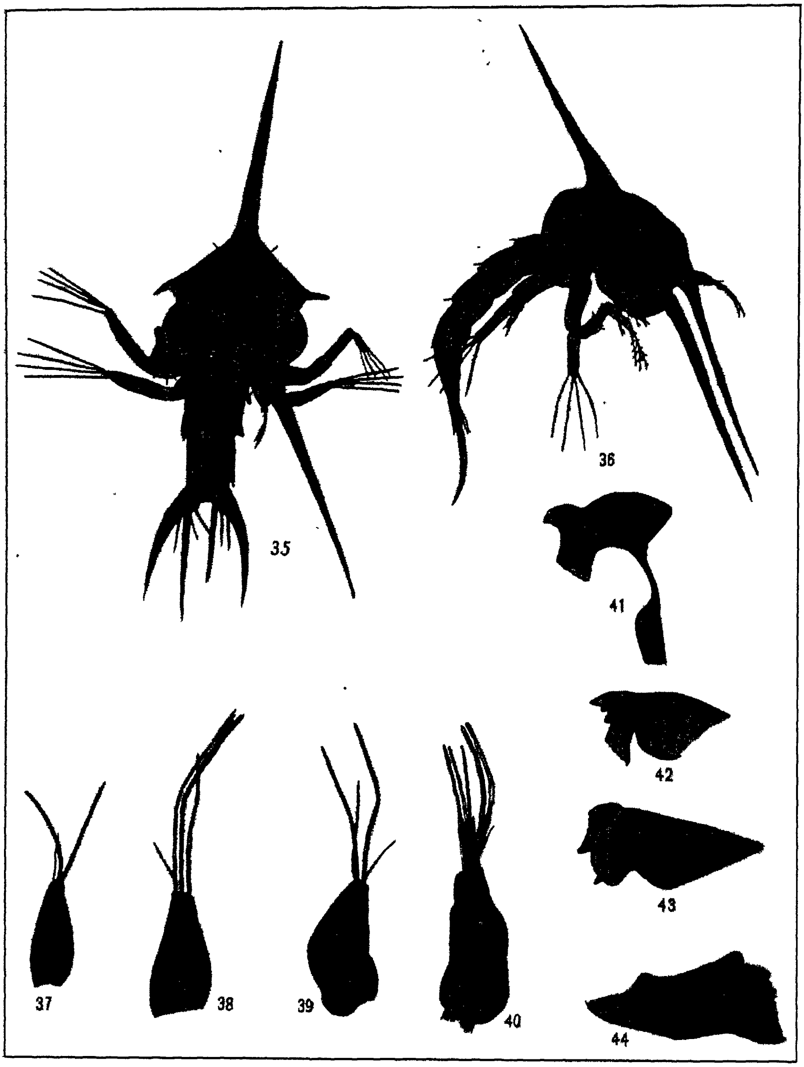
LARVAE OF CRABS OF THE FAMILY XANTHIDAE

FOR EXPLANATION OF PLATE SEE PAGE 18



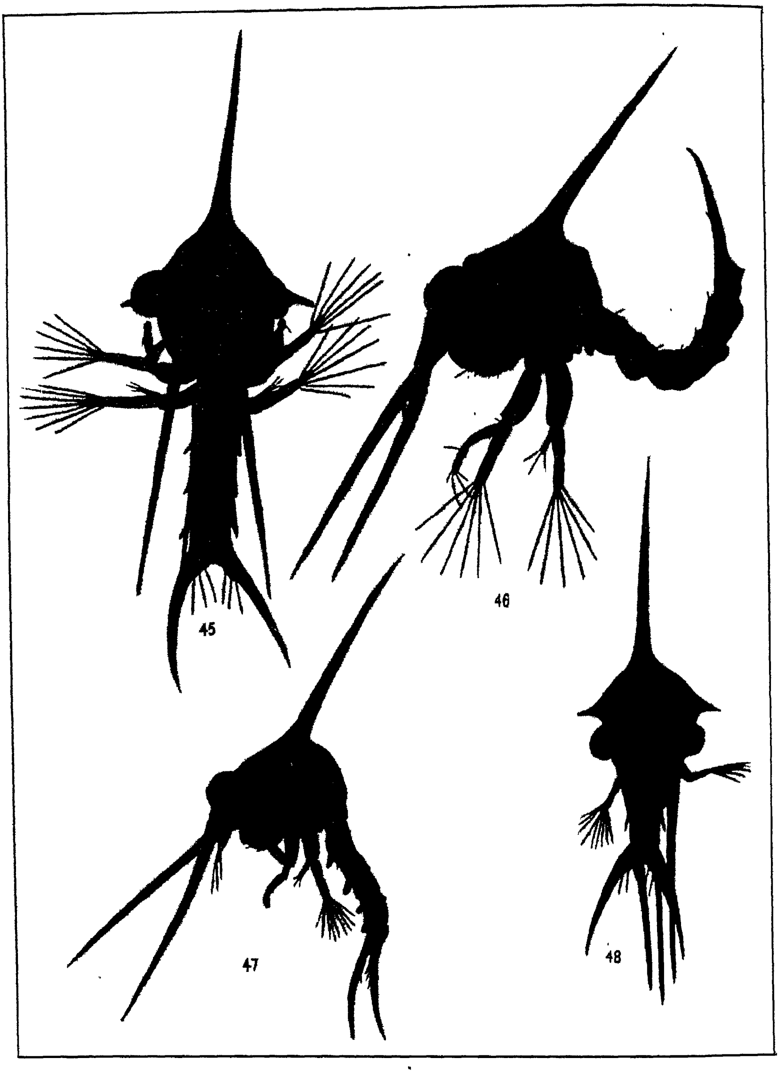
LARVAE OF CRABS OF THE FAMILY XANTHIDAE

FOR EXPLANATION OF PLATE SEE PAGE 18



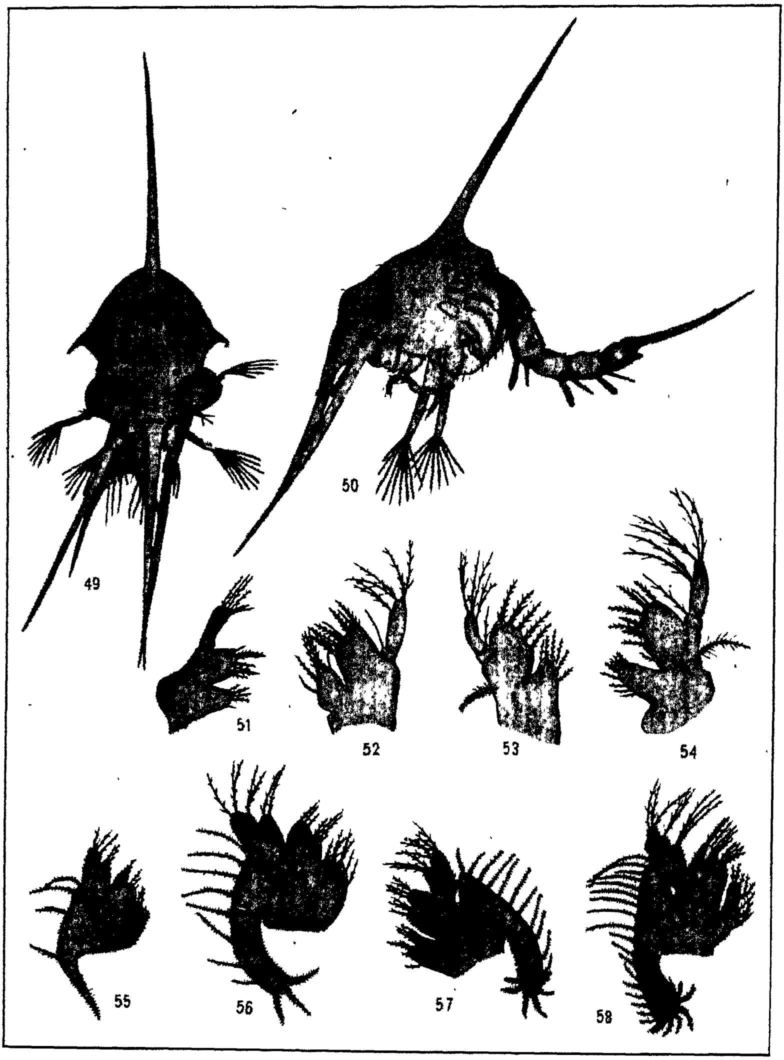
Xanthid Larvae of the Genus Neopanope

For explanation of plate see page 18



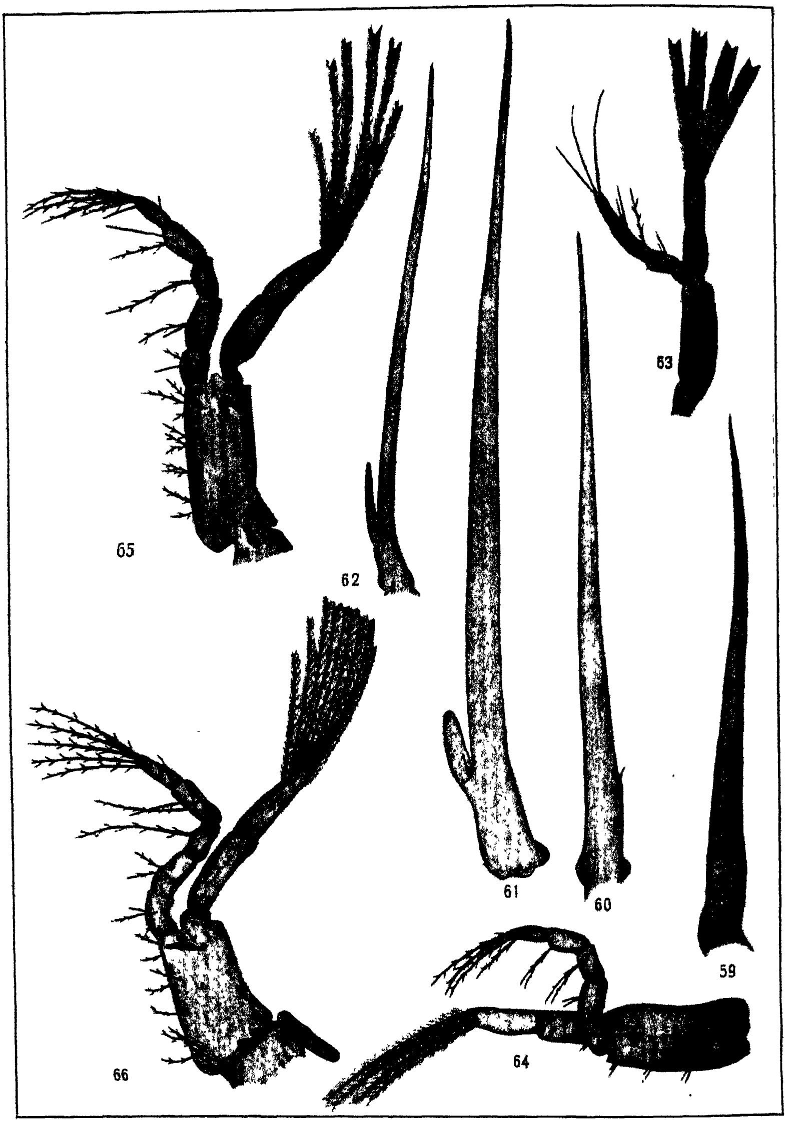
XANTHID LARVAE OF THE GENUS NEOPANOPE

FOR EXPLANATION OF PLATE SEE PAGE 19



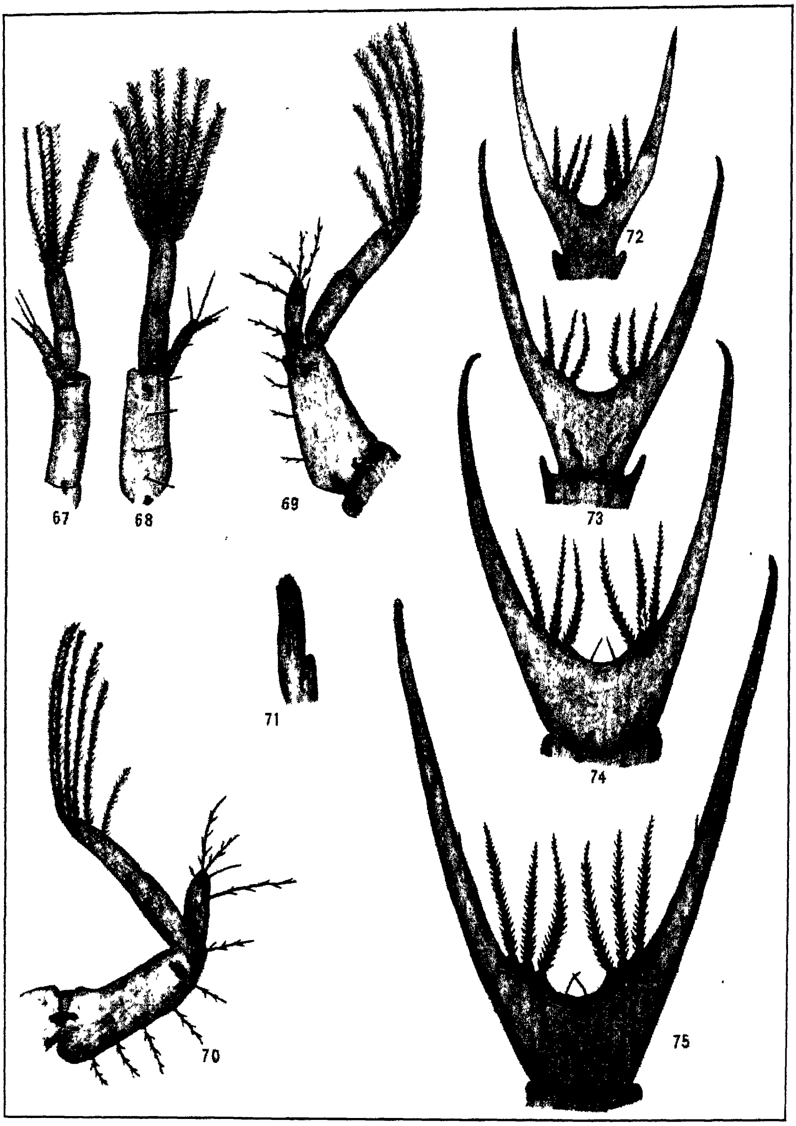
Xanthid Larvae of the Genus Neopanope

For explanation of plate see page 19



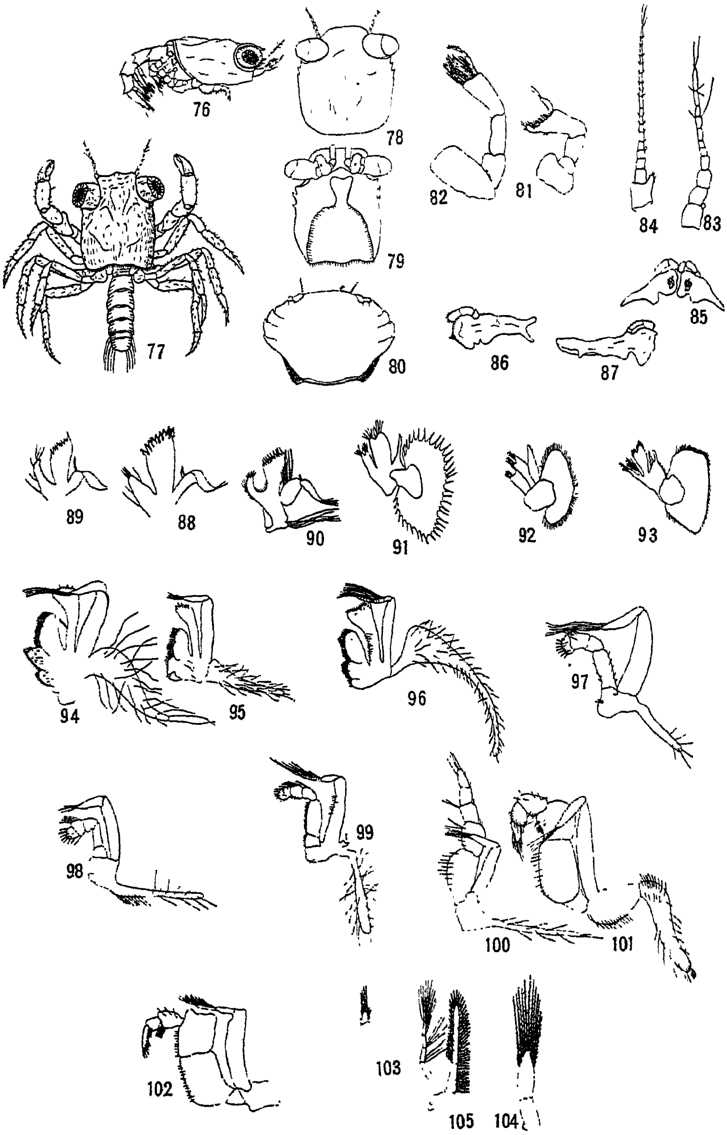
Appendages of Larvae of the Genus Neopanope

For explanation of plate see page 19



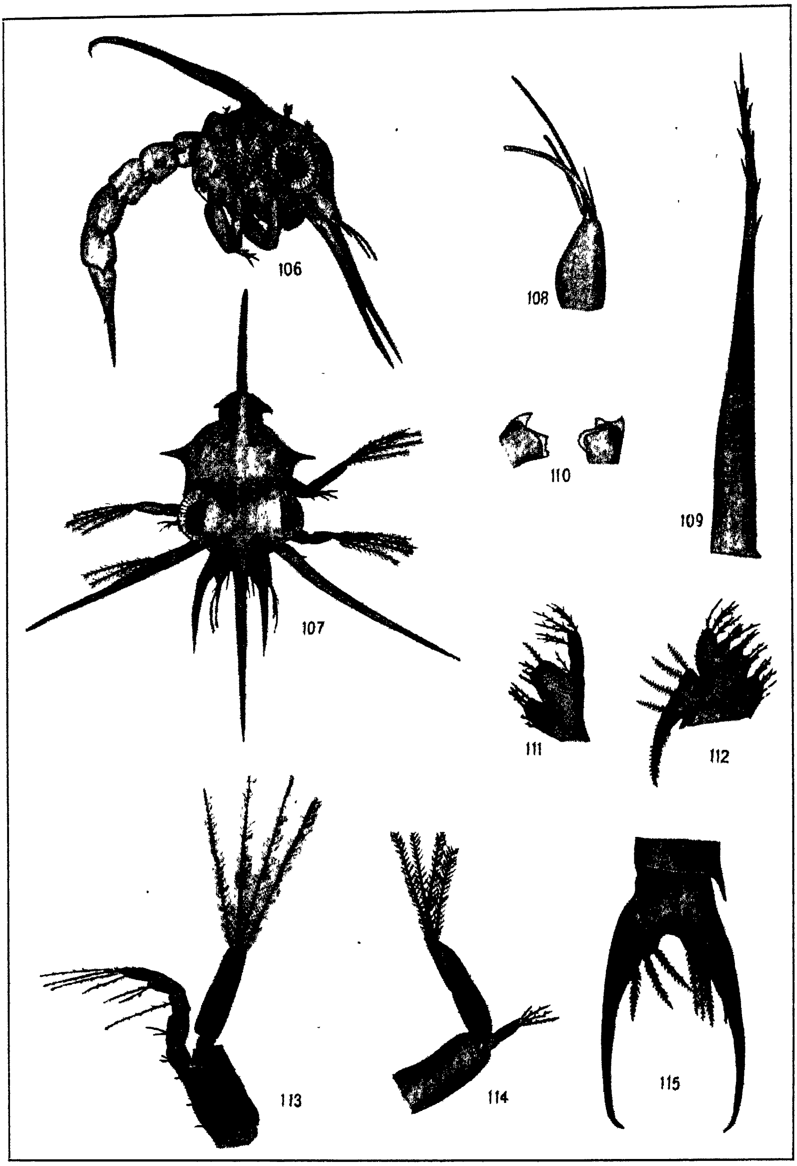
APPENDAGES OF LARVAE OF THE GENUS NEOPANOPE

FOR EXPLANATION OF PLATE SEE PAGE 19



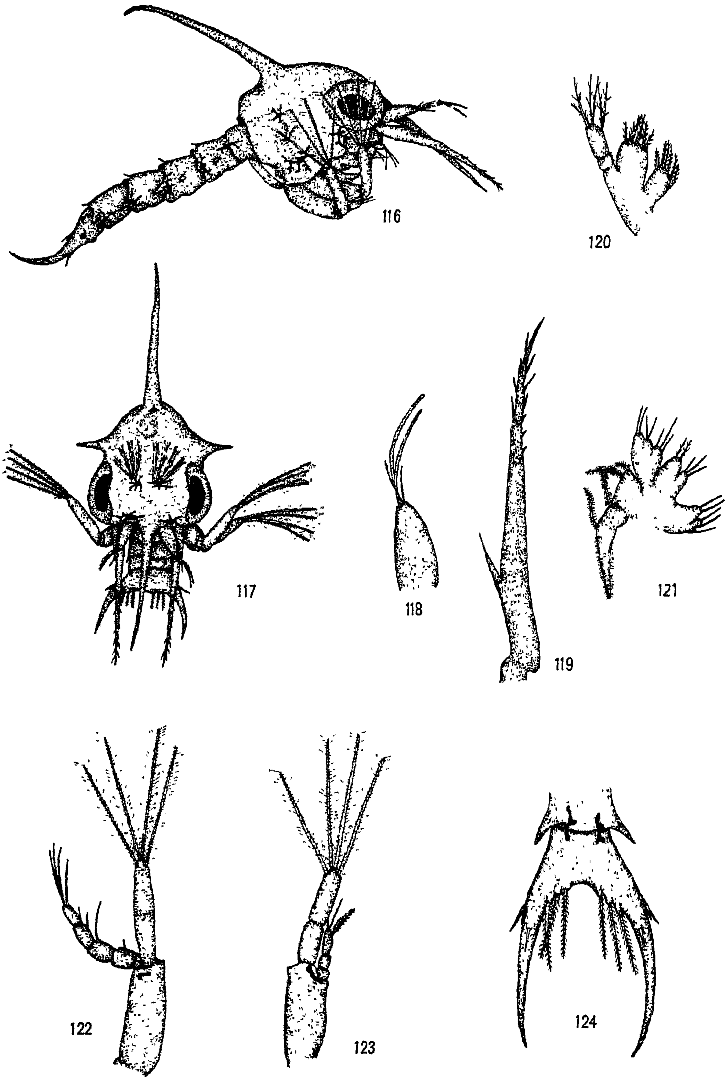
XANTHID LARVAE OF THE GENUS NEOPANOPE

FOR EXPLANATION OF PLATE SEE PAGES 19 AND 20



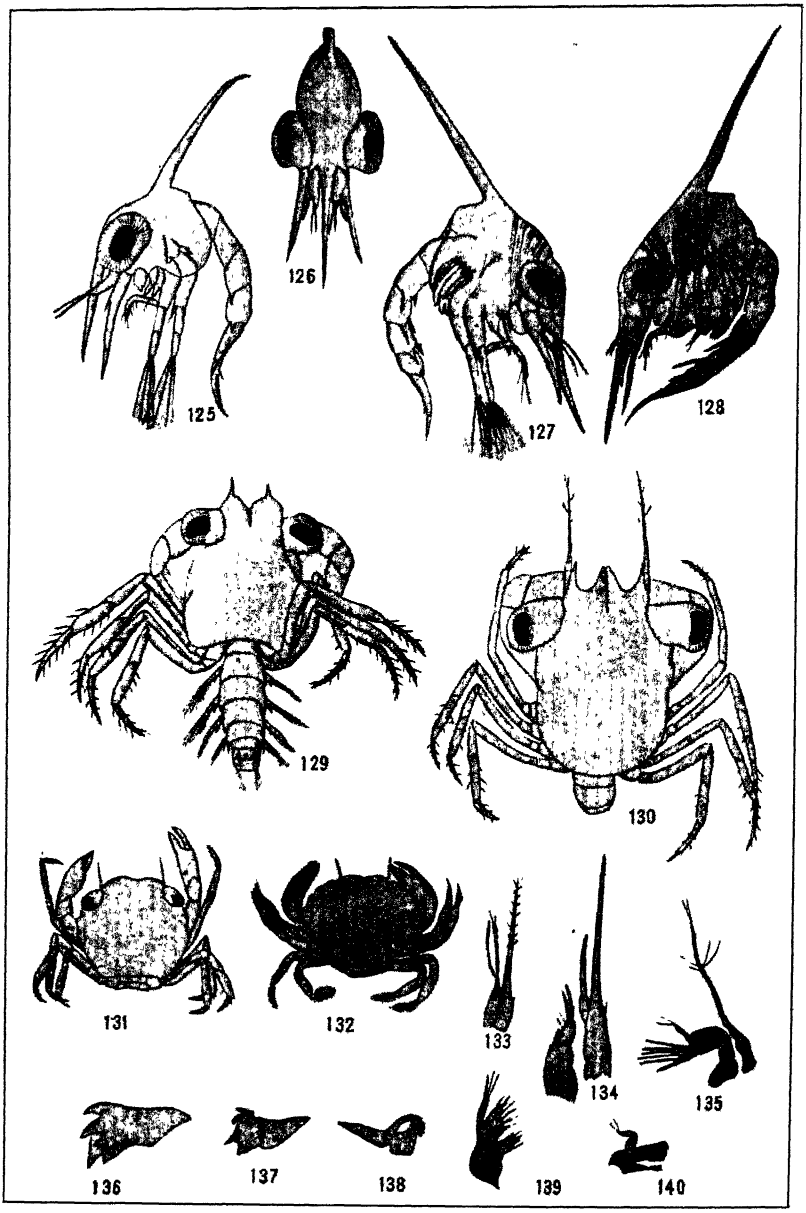
XANTHID LARVAE OF THE GENUS EURYPANOPEUS

FOR EXPLANATION OF PLATE SEE PAGE 20



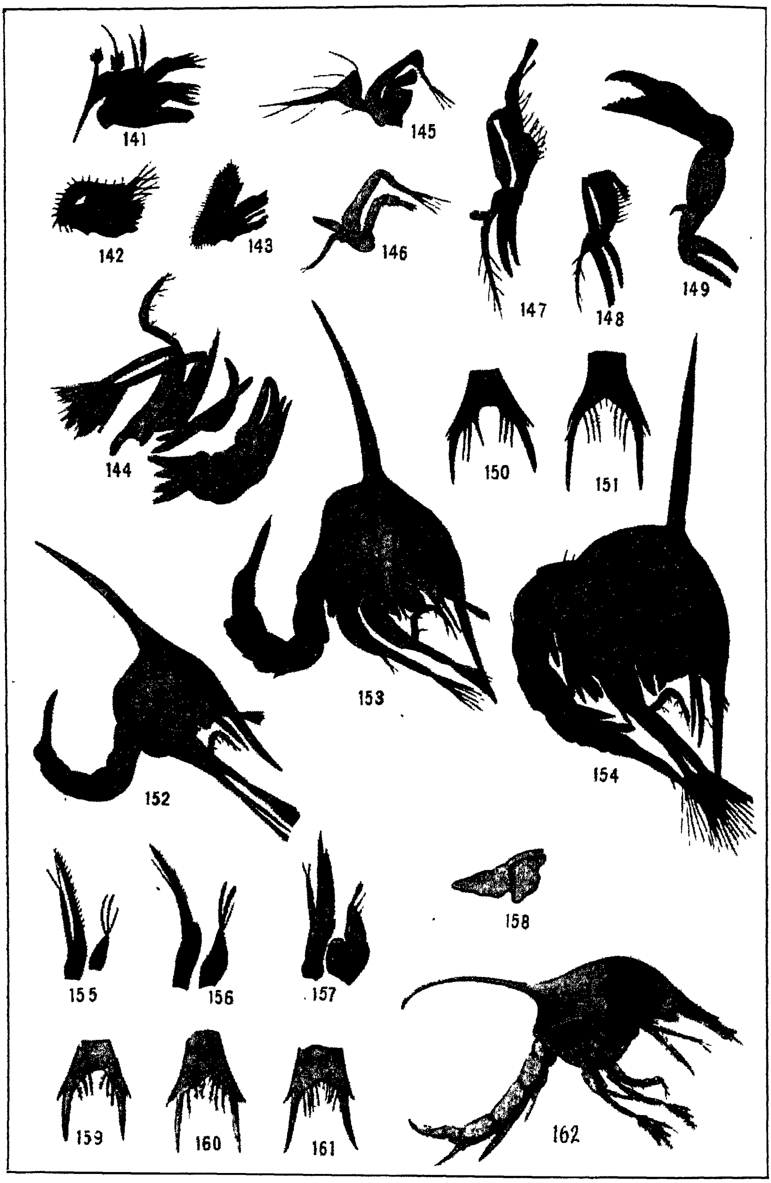
Xanthid Larvae of the Genus Panopeus

For explanation of plate see page 20



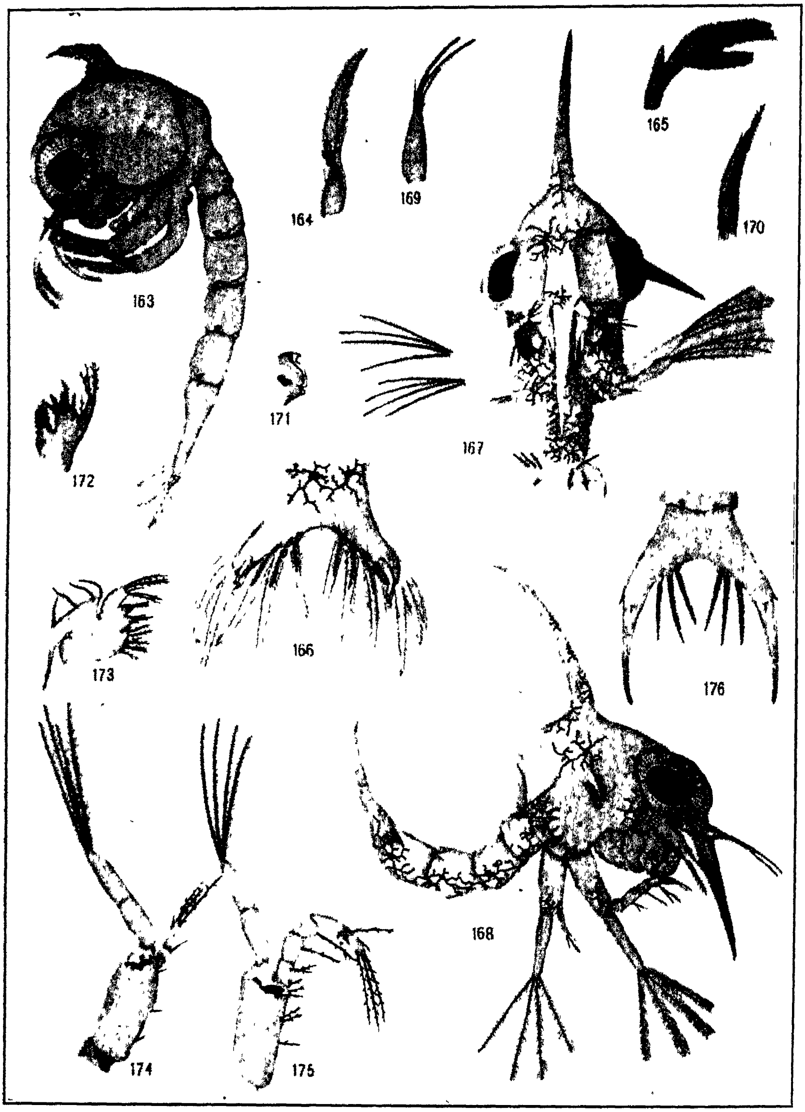
XANTHID LARVAE OF THE GENUS XANTHO

FOR EXPLANATION OF PLATE SEE PAGE 21



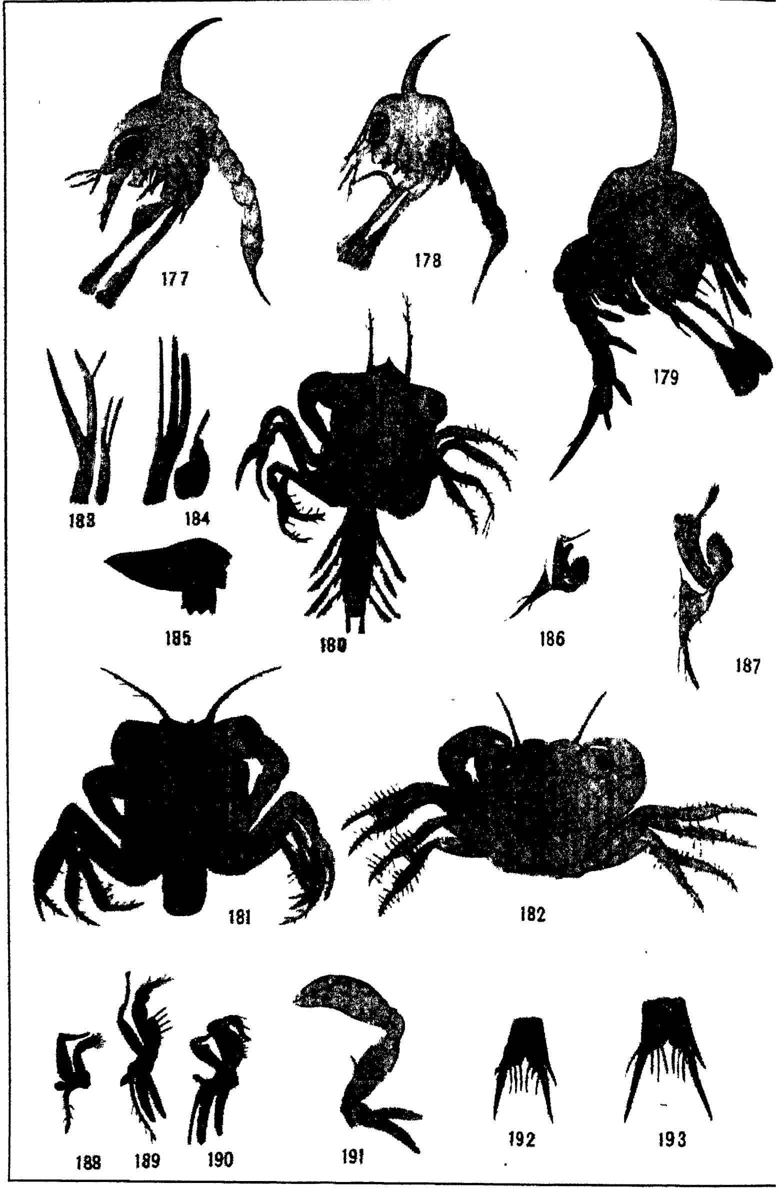
LARVAE OF CRABS OF THE FAMILY XANTHIDAE

FOR EXPLANATION OF PLATE SEE PAGE 21



XANTHID LARVAE OF THE GENUS MENIPPE

FOR EXPLANATION OF PLATE SEE PAGE 22



XANTHID LARVAE OF THE GENUS PILUMNUS

FOR EXPLANATION OF PLATE SEE PAGE 22

# MICROSCOPIC SCULPTURE OF PEARLY FRESH-WATER MUSSEL SHELLS

By William B. Marshall

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In a note under the description of *Diplodontites cookei*[1] special attention was called to its minute sculpture in the following words: "The sculpture of the exterior is remarkable and of great beauty. The radiating striae between the impressed radiating lines are of a fineness rarely if ever equaled in shells with the rude structure of the naiads." In the same paper the new species *Monocondylaea felipponei* was described, but nothing was said of its possessing minute radiating striae. In fact, the fine sculpture of this shell was not detected as it was not shown by the fairly strong hand lens used in making an examination. Later the use of a two-thirds inch objective on a compound microscope showed that this species has microscopic sculpture of the same general character as that of *Diplodontites cookei.* Even with a two-thirds inch objective careful focusing is needed to reveal the fine striae. The new species *Anodontites colombiensis* described in the same paper was then subjected to microscopic examination and was found to possess minute striae of the same nature as in the two species mentioned above.

The presence of microscopic striae in the three species mentioned above led to an examination of many other species of South American shells, and it was found that in those belonging to the family Mutelidae the striae were generally present, while in *Diplodon* and other genera of the Unionidae they were lacking. The investigation was then broadened to include an examination of many species representing practically all genera of naiads from all parts of the world. The results have been thought sufficiently interesting and important to warrant publishing them. The results are of value in themselves and the discovery of the minute striae will call attention to the fact that many details may lie close at hand and yet remain unnoticed for years. The genera *Anodontites* and *Monocondylaea* have been known for many years, but, so far as I have been able to determine, no mention has ever been made of the microscopic features of the periostracum which are shown so clearly in many of the species. *Anodontites crispatus* Bruguiere, described in 1792, the type of the genus, has sculpture nearly as fine and beautiful as that of *Diplodontites cookei* and yet that fact has remained unrevealed for a period of 132 years. In the genus *Monocondylaea* the two species *M. paraguayana* Orbigny and *M. franciscana* Moricand were described in 1835 and 1837, respectively. Both species show the microscopic, radiating striae, the latter especially having them in unusual perfection. Apparently no mention of them has ever been made until the present time.

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[1] Proc. U. S. Nat. Mus., vol. 61, 1922.

A somewhat parallel case, though relating to a different style of sculpture, is presented by the Chinese genus *Schistodesmus*, which possesses a concentric sculpture of microscopic striae wonderfully fine and beautiful. Baird and Adams (1867) in their description of the species *lampreyanus* failed to mention them, and they seem to have escaped any notice until 1900, when Simpson, in his description of the genus *Schistodesmus*, called attention to them thus: "Marvelously delicate, concentric, microscopic lirae." The genus *Cuneopsis*, also of China, has a similar sculpture, though on a cloth-like periostracum, and it seems that these two genera should stand next to each other instead of being separated by the genus *Gibbosula*, which Simpson has placed between them.

As has already been said, an examination has been made of the microscopic sculpture of shells of practically all the genera of naiads from all parts of the world. So far as those of the Unionidae are concerned, not much may be said at present. For our immediate purpose it is sufficient to say that in this family regularly arranged microscopic details are usually lacking, and none of them has a periostracum made up of fine radiating threads. With the naiads of the family Mutelidae the case is different. Here many species have an almost infinite number of radiating threads, and while the threads seem to be absent in a few species it is believed that with good material every species belonging to this family would reveal this type of periostracum and that it is a family characteristic.

This peculiar periostracum is so striking in many of the genera and species of the family that if it be shown that any species absolutely lacks it then the right of that species to a place in the Mutelidae becomes subject to some doubt.

The family Mutelidae as at present understood contains 14 genera, of which 6 are restricted to Africa, namely, *Spatha*, *Mutela*, *Chelidonopsis*, *Brazzea*, *Arthropteron*, and *Pleiodon*, while 6 are restricted to South America, namely, *Monocondylaea*, *Iheringella*, *Fossula*, *Leila*, *Mycetopoda*, and *Diplodontites*. *Anodontites*, the largest genus of Mutelidae, is restricted to America, some species being found as far north as Mexico and others in Central America, while yet others are found in South America only, many of them as far south as Rio de la Plata, and one species as far as Patagonia.

Of the two genera *Brazzea* and *Arthropteron* no material was at hand for examination. Of the other 12 genera many species were given careful scrutiny. In the genus *Chelidonopsis*, of which only three specimens were available, there seems to be no sign of radiating threads. In the genus *Mycetopoda* threads were found on only a couple of specimens and then they were not of the usual type. The other 10 genera all showed the threads clearly in most of the species. The threads in the African genera *Spatha* and *Mutela* are much finer and more numerous than in the American genera, but the African genus *Pleiodon* has threads which are almost exactly like those of the South American genus *Monocondylaea*.

In general it may be said that the radiating striae resemble the threads in finely woven serge cloth when it is viewed with the naked eye, or perhaps it would be better to say that they resemble the fine ridges which occur on our finger tips. When viewed under the microscope the shells whose periostracum retains the threads look as if they had been marked with fingerprints.

In some cases the radiating threads are very clear and can be found on all parts of the shell. *Diplodontites cookei* and *Monocondylaea franciscana* are notable in this respect. In other cases the threads have disappeared from most of the shell, and sometimes there are but very small patches of threads left here and there. Frequently it is necessary to make a very careful search over the whole surface of a number of specimens in order to find a spot in which the striae have been preserved. In some of the groups of large *Anodontites* typified by *trapesialis* (containing *jewettianus*, *forbesianus*, *glaucus*, and others) no striae have thus far been observed. It is not possible to say at this time whether threads are lacking in these shells or have been worn away or lost in the shedding of a fugacious periostracum. In *Mycetopoda* the threads are not of the usual type. This genus will be discussed later in this paper in dealing with the species of shell which is called *Solenaia falcata* Higgins.

In the preceding paragraph reference has been made to a fugacious periostracum. Some explanation of this kind of periostracum is advisable, as its presence is not generally known. Very often there is a sort of bloom found in spots, or sometimes covering a large portion of the shell. Perhaps it has generally been mistaken for a deposit of some extraneous material. It seems to be a part of the periostracum. When present the bloom is likely to show the microscopic threads more clearly than do the parts of the shell from which the bloom has disappeared. It appears to be usually only temporary. On a specimen of *Anodontites tenebricosus* Lea from Arroyo Miguelete, Montevideo, Uruguay (Cat. No. 270908, U.S.N.M.), the fugacious periostracum persists over a large portion of the shell, making this portion appear as if covered with very thin dead skin. On the portion where the fugacious periostracum has disappeared the surface has the appearance most usually seen in this species. In *Spatha wahlbergi* of South Africa the bloom persists in only a few spots and is so thin that it forms but the thinnest of films. In *Anodontites tenebricosus* Lea it is much thicker, more easily visible, and sometimes remains over a large area. In *Monocondylaea* it becomes somewhat like pale yellowish or whitish paper, and in many places where it has partly torn away from the shell it stands up on the surface in little concentric plates. This is what gives *Monocondylaea* the generally roughened appearance so often noted and sometimes mentioned in descriptions as being lamellate. In this genus there are numerous cracks arranged concentrically, with many cross cracks uniting them. In many of these cracks the fugacious periostracum persists throughout the life of the shell. This makes *Monocondylaea* one of the best genera for examination in a study of radiating threads, as they are almost always to be found on the paper-like fugacious periostracum remaining in the cracks. In some spots on the type of *Monocondylaea felipponei* Marshall little sheets of this kind of periostracum still lie flat and apparently loose except along one edge. In the genus *Diplodontites* there are but the faintest traces of a fugacious periostracum of any kind. Each genus seems to have its own peculiarities in this kind of periostracum.

In giving details of the radiating striæ of each genus frequent mention is made of the sinulus of the various species, and a few general remarks concerning this feature of the shell may well be made here. In most of the shells of the family Mutelidae the sinulus is distinctly triangular, but in a few cases where the shells have a very elongated form the sinulus, too, is elongated, and its triangular shape is not so apparent. In *Mycetopoda*, although the shell is elongated, the sinulus is distinctly triangular. The Mutelidae and the Aetheriidae are the only families in which the sinulus is typically triangular. The latter family contains the three genera, *Mulleria*, *Aetheria*, and *Bartlettia*. None of these has radiating striae so far as can be determined at this time. There seems to be no doubt as to some relationship between *Bartlettia* and *Mulleria* and the family Mutelidae. The form of the young of *Bartlettia* and *Mulleria*, the locality (South America) in which the two genera are found, the type of sinulus, and the texture of the shell seem to indicate a nearer relationship between these two genera and the Mutelidae than between *Aetheria* and the Mutelidae. The genus *Pseudodon* of eastern Asia sometimes has a triangular sinulus. It will be discussed in connection with the genus *Monocondylaea*.

### Genus SPATHA

Plate 4, fig. 3

Microscopic radiating threads in this genus are finer than those of the South American genera. They are quite clear, though showing some tendency to become reticulate. The threads of *Spatha wahlbergi*, which are supposed to be represented on plate 4, figure 3, are the finest that have been observed in any shell. The striae are so fine that a satisfactory photograph could not be obtained. The figure shown here is magnified 50 diameters. Even with a magnification of 100 diameters a photograph did not show the striae. The specimen shows a bloom here and there, and on these spots the striae become very striking. It is estimated that there are in the neighborhood of 300 striae to the millimeter in this species. In this genus the species differ greatly in form, size, degree of polish, and in sculpture. It is interesting to note that the striae appear in *wahlbergi*, which is a very large, quite smooth shell; in *vignoniana*, which is rather small and extremely roughened with stout ribs; and in *chaziana*, which is a small, highly polished shell. In this genus, no matter what the form of the shell may be, whether long or short or rounded, the sinulus is always triangular, as it should be in Mutelid shells.

### Genus MUTELA

In this genus the striae are fine like in the genus *Spatha*, but are not so clearly defined. They are more given to reticulating and do not have the appearance of threads laid alongside each other. They appear like a lot of fibers more or less felted rather than spun. It is quite difficult to find spots in which the threads show at all. All the species of *Mutela* have an elongated form—this length in proportion to height being especially marked in *Mutela rostrata*. The sinulus in this genus is not equilaterally triangular in any of the species, but the triangle is drawn out posteriorly into a long point, yet this does not necessarily mean that the sinulus falls outside of allowable variation of the Mutelid type, but simply that length of shell has affected form of sinulus. No satisfactory figure could be obtained in this genus.

### Genus CHELIDONOPSIS

But three specimens of this genus, *Chelidonopsis hirundo*, were available for examination. It is a very peculiar shell, highly polished and very elongated, and has a sinulus which, like that of *Mutela*, does not exactly conform to the usual type in the Mutelidae. Further study with young specimens is necessary to determine the facts in this group.

### Genera BRAZZEA and ARTHROPTERON

No material available for examination and data in general lacking.

### Genus PLEIODON

Plate 4, fig. 2

In this genus but two species were available for study, *Pleiodon ovatus* Swainson from Senegal, and *P. speckii* from Lake Tanganyika. The latter is a very large old specimen and periostracal characters have disappeared. Of *P. ovatus* there are two rather young having a length of 50 and 60 millimeters, respectively. These two specimens have the radiating threads present over a large part of the surface and they are perfectly preserved and number about 105 to the millimeter. There are also seven adult specimens of this species in the collection, the largest having a length of 110 millimeters. In these specimens it is difficult to find a spot in which threads can be seen. The sinulus in this genus is aberrent from the Mutelid type, though in *P. speckii* it approaches it. The figure (pl. 4, fig. 2), is from a young *P. ovatus* from Senegal, Africa (Cat. No. 86774, U.S.N.M.). The broad light-colored band near the bottom of the figure represents the remains of fugacious periostracum attached along a growth line. Other remains are seen at the left of the figure.

### Genus MONOCONDYLAEA

Plate 1, fig. 2; plate 2, fig. 1

In nearly every specimen of this genus the radiating threads persist on some part of the surface, regardless of the age of the specimen. Often they are to be found only on the paper-like remains of the fugacious periostracum which has been sheltered in the peculiar concentric and cross cracks nearly always found in these shells. In *Monocondylaea franciscana* Moricand the threads occur in fine condition, number about 85 to the millimeter, and are found over nearly the whole extent of the shell. On the single specimen of *M. felipponei* Marshall available for examination the threads number about 110 to the millimeter, cover nearly the whole shell, and are clearly defined and easy to find. *M. franciscana* is figured on plate 1, figure 2. The specimen came from Rio Francisco, Brazil (Cat. No. 86334, U.S.N.M.). *M. felipponei* is represented on plate 2, figure 1. It came from Barra del Arroyo Sacra, Paysandu, Uruguay (Cat. No. 340663, U.S.N.M.).

Some comparisons between the Unionid genus *Pseudodon* and the Mutelid genus *Monocondylaea* may not be amiss. The shells of *Pseudodon* present some peculiar and interesting features. The genus is restricted to Eastern Asia and some of the near-by islands.

The shells have an apparently near relationship to some of the South American naiads, especially to those of the genus *Monocondylaea*, because of the single cardinal tooth and the general character of the sinulus in some of the *Pseudodon* species. Because of these features, several species of *Pseudodon* were described as *Monocondylaea*, and many years passed before it became generally recognized that the apparent close relationship of the two genera comes from a superficial resemblance rather than from structural affinities. As time passed the shells were not only placed in different genera, but as they became more fully understood they were classified into different families, *Pseudodon* in the Unionidae and *Monocondylaea* in the Mutelidae. The collection of the United States National Museum contains many specimens representing eleven species of *Pseudodon*. All of these have been subjected to searching microscopical examination to determine the presence or absence of the radiating threads characteristic of *Monocondylaea* and other Mutelidae. No trace of such threads was found in any species. Their absence affords additional evidence of the lack of any very close relationship between *Pseudodon* and *Monocondylaea*.

As has been said above, the sinulus of *Pseudodon* often resembles that of the Mutelidae. In some species of *Pseudodon* the resemblance is quite sharp, but in others it is not clear or is lacking. Even in the cases in which it is most striking (as in *Pseudodon cambojensis* Petit, *P. polita* Mousson, and *P. cumingii* Lea) it lacks the sharply equilaterally triangular form of the sinulus of the Mutelidae, being more or less rounded at the lower point. Some of the other species of *Pseudodon*, such as *P. loomisi* Simpson and *P. crebristriatus* Anthony, have the sinulus as in the other Unionidae.

### Genus IHERINGELLA

Of this genus, which shows an intimate relationship to *Monocondylaea*, but one specimen was available. It is *Iheringella isocardioides* Lea (Cat. No. 86326, U.S.N.M.), and comes from the Rio de la Plata, South America. While it is in rather poor condition, fortunately a few small spots are well enough preserved to show that the radiating threads occur in this genus. The striae do not show sufficiently well to photograph.

### Genus FOSSICULA

Plate 2, fig. 2

But one of the two species was available; namely, *Fossicula fossiculifera* Lea, represented by four specimens, three of which came from the Parana River and one from Piricicaba, Sao Paulo, Brazil. This is a peculiar genus whose relationships point in two directions—to *Monocondylaea*, because of the cardinal tooth, and to

*Anodontites*, because of its form, colors, and wide prismatic border, which are exactly like those of *Anodontites patagonicus*. Were the portion of the hinge line bearing the tooth broken away one would be absolutely unable to separate *F. fossiculifera* from *A. patagonicus*. If *Fossicula* and *Leila* be valid genera it seems there should be some shifting in classification in order to bring the former near *A. patagonicus* and the latter near *A. trapesialis*, instead of arranging *Leila* between *Fossicula* and *Anodontites*. The radiating threads do not show well in any of the four specimens at hand, but enough remains to tell that the threads occur in this genus and that they are like those to be found in some specimens of *Anodontites patagonicus*. Plate 2, figure 2, represents a small spot in a specimen from Parana River (Cat. No. 86346, U.S.N.M.). It has about 105 threads to the millimeter.

### Genus LEILA

The shells of this genus are uniformly large. In the whole family Mutelidae they are exceeded in size by only one species, *Anodontites trapesialis* Lamarck, with which perhaps they should be placed in a section of the genus *Anodontites*, or perhaps *trapesialis* should be taken from that genus and placed in the genus *Leila*. Surely the shells show a very near relationship to each other. The radiating threads in *Leila* are extremely fine and resemble those of the African genus *Spatha*, rather than those usual to the South American species of Mutelidae. They are of about the same nature as those of *Spatha wahlbergi*. In these large shells the striae are difficult to find because they are so very fine, and they seem to be easily lost as growth progresses. A specimen of *Leila blainvilleana* from the Amazon River (Cat. No. 25815, U.S.N.M.) shows the fine lines, but not clearly enough to be photographed.

### Genus ANODONTITES

Plate 1, fig. 1; plate 2, fig. 3; plate 3, figs. 1 and 3

To this genus belong the larger portion of all the species referred to the family Mutelidae. There are recognized some 50 species of *Anodontites*. They have been divided into several sections and groups, but there is ground for believing that further study will result in dividing this genus into several genera. The shells now included in *Anodontites* show a wide range of characteristics, varying in form, size, colors, weight, sculpture, etc. For instance, compare *A. rotundus* Spix with *A. trapesialis* Lamarck; *A. patagonicus* Lamarck with *A. strebeli* Lea, and any of these with *A. tenebricosus* Lea; or compare *A. ensiformis* Spix and *A. falsus* Simpson with any of the other *Anodontites*. The genus has a great geographic range, extending from Mexico to Patagonia. In nearly all of the species of this genus the radiating threads have been observed, though they have not yet been found in some. No doubt they will be found in all in the course of time. As might be expected in a genus containing so many species and ranging over so large a territory, there is some variation in the character of the microscopic striae, but it may be said that in all cases these striae conform to some one of the few variations found in the Mutelidae. Four specimens have been selected for illustration. Plate 2, figure 3, represents the striae on a typical *A. patagonicus* from Arroyo Miguelete, Montevideo, Uruguay (Cat. No. 335746, U.S.N.M.). Plate 3, figure 3, represents the striae on a specimen of the rotund form of the same species from the Uruguay River (Cat. No. 347885, U.S.N.M.). In this, the striae are unusually clear and cover a large part of the surface. Plate 3, figure 2, represents the threads on a specimen of *A. inaequivalvis* Lea from Lake Nicaragua, Central America (Cat. No. 59873, U.S.N.M.). Although the species is a very small one and comes from so far north, the striae, of which there are about 100 to the millimeter, are strictly according to type. The cracks and crevices of this shell, especially on the posterior dorsal area, are apt to retain remains of fugacious periostracum, which resembles little pieces of onion skin, and in which the striae show very plainly. In the two species composing the section *Virgula*, *Anodontites* (*Virgula*) *ensiformis* Spix and *A.* (*V.*) *falsus* Simpson, so far no radiating striae have been observed. As but five specimens were available for examination, it will be well to wait until additional material is studied before coming to any definite conclusions as to this group. Because of their great length they look unlike other *Anodontites.*

In the series which Simpson arranges as the "Group of *Anodontites crispatus*" twelve of the thirteen species have been examined and all of them show the radiating striæ. In all, the threads were easy to find, were well developed, and were distinctly of the Mutelid type. In this group all the species have the peculiarly puckered, radiating impressed lines, and drooping concentric folds which I have likened to festooned drapery and which Ortmann describes by the adjective "scalariform." Some of the species are rather rough, such as *A. crispatus;* others are highly polished, such as *A. strebeli* Lea and *A. holtonis* Lea. In this group, as in most other *Anodontites*, the striae are most easily found on some part of the posterior dorsal area, but it is not unusual to find them on the disk of the shell in spots covered with the puckered radiating impressed lines. Plate 1, figure 1, represents the radiating striae of a specimen of *Anodontites crispatus* Bruguiere from Venezuela (Cat. No. 24020, U.S.N.M.), in which there are about 90 striae to the millimeter.

This was the first species of *Anodontites* described and is the type of the genus. In many details the periostracum of this species resembles that of *Diplodontites cookei* Marshall, and especially in the radiating striae and in the festooning of the coarser sculpture.

### Genus MYCETOPODA

All the species of this genus are long and narrow, and have the general appearance of being out of place in the family Mutelidae, but notwithstanding their great length the sinulus is of the Mutelid type, though somewhat drawn out. Radiating striae of the usual type fail in this genus. In twenty-seven of the twenty-nine specimens examined no trace of radiating threads could be discovered. In two other specimens there were radiating marks resembling thumb prints. A specimen of *Mycetopoda pygmaea* Spix from Carthagena, United States of Colombia (Cat. No. 86795, U.S.N.M.), shows the striae best, but it is not sufficiently clear to be worth figuring.

The relationships of this genus have never been satisfactorily traced, and the peculiar nature of the striae in the periostracum adds another feature which should have further study.

### Genus ———?

Plate 4, fig. 1

Under the head "genus unknown" attention is called to the shell known as *Solenaia falcata* Higgins. When Simpson, in 1900, published his Synopsis of the Naiades, or Pearly Fresh-water Mussels,[2] this shell was a puzzle to him. Higgins, in his description of the species,[3] gave its locality as "forest streams, near Chyavetas, Upper Amazons." As pointed out by Simpson, the shell is almost a miniature of *Solenaia emarginata* Lea, which inhabits Siam, and on this account he thought the habitat cited by Higgins was erroneous. He doubtfully substituted the locality Southeastern Asia and removed the species from the genus *Mycetopus* (=*Mycetopoda*) of the family Mutelidae in which Higgins placed it and shifted it to the genus *Solenaia* in the Unionidae. In 1914, when Simpson's Descriptive Catalogue of the Naiades or Pearly Fresh-water Mussels appeared, the species was still a puzzle to him and he again preferred to substitute the habitat "Southeastern Asia?" and remained firmly convinced that it could not have come from South America. Disregarding the close resemblance of *falcata* to *emarginata*, which may be only a resemblance without any backing of close relationship, the weight of the evidence at hand is in favor of a South American habitat for *falcata*. The main points of evidence in favor of this are, first, the type locality given in Higgins's description; second, a specimen in the Isaac Lea collection (Cat. No. 86788, U.S.N.M.), which Lea received from Wheatly. It is figured on plate 4, figure 1. The locality given for this specimen is Amazon. Third, no specimen has ever been reported from Southeastern Asia. Fourth, the character of the periostracum. Were all other evidence lacking, this would be sufficient to establish the fact of a South American origin for the shell. The radiating microscopic threads are exactly like those found in *Diplodontitis cookei* Marshall, *Anodontites tenebricosus* Lea, *Monocondylæa franciscana* Moricand, and many other species of South American naiad. The striae number about 90 to the millimeter.

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[2] Proc. U. S. Nat. Mus., vol. 22, pp. 501–1044.

[3] Proc. Zool. Soc. London, p. 179, pl. 14, fig. 6, 1868.

In what genus "*Solenaia*" *falcata* should be placed remains an open question. The data at hand is not sufficient to answer that question, and we must wait for further details as to anatomy, breeding habits, and beak sculpture. The U. S. National Museum contains six speciment representing four species of undoubted *Solenaia.* The periostracum of these is altogether different from that of *falcata* and shows no sign of radiating threads. To place it in the genus *Solenaia* would involve a faunistic mixing that would be unusual, namely, South America and Eastern Asia, and the difference between the periostracum of *falcata* and that of species whose right to a place in the genus *Solenaia* is undoubted would involve a mixing of not only generic characters but of features which are believed to be family characteristics.

Granting that "*Solenaia*" *falcata* is a South American shell and that it does not belong in the genus *Solenaia*, the next step is to define its position among the South American Naiades. It was described as a *Mycetopus* (=*Mycetopoda*). In a cursory consideration of it one would naturally place it in or very near the genus *Mycetopoda*, this allocation being made chiefly because of its elongated form. Possibly it does belong to that genus, but it is to be doubted. It may belong in the genus *Anodontites*, as it shows some relationship to arcuate specimens of the *tenebricosus* group. Its position here likewise is doubtful. In radiating threads its periostracum differs widely from that of *Mycetopoda*, in which genus what radiating threads have been observed being far from the kind usual in Mutelidae. Of *falcata* it may be said that its sinulus is not distinctly of the Mutelid type, not being clearly triangular nor subequilateral. This may be due to the great length of the shell in proportion to its height. The species may require a new genus to accommodate it.

Since the above was written our library has received a copy of a paper entitled "Nayades del Viaje al Pacifico," by F. Hass, published in Trabajos del Museo Nacional de Ciencias Naturales, Zoological series, Number 25 (Madrid, Spain, Aug. 1916). In this paper the supposed new species *Mycetopoda bolivari* Hass is described on page 36 and figured on plate 2, figure 2. It comes from Rio

Unuyacu, affluent of the Napo River, Ecuador. The Napo is a tributary to the Maranon, which in turn is tributary to the Amazon. The description, the figures, and the locality all show that this shell is the same species as the one described by Higgins as *Mycetopus falcatus* and called *Solenaia falcatus* Higgins by Simpson.

### Genus DIPLODONTITES

Plate 1, fig. 3

It was in this genus that the microscopic radiating striae were first observed, and they were described and figured in the original description of the only species, *Diplodontites cookei* Marshall.[4] In this genus the striae are of unusual importance, as the allocation of the genus to its proper family depends upon shell characters and the striae afford additional evidence that it belongs in the Mutelidae. In this genus they are especially clear and cover nearly the whole surface of the shell, about 90 striae to the millimeter. Fugacious periostracum appears to be lacking, as at best there are only a few traces here and there of what may be this kind of material. The genus differs from all other Mutelidae in having three cardinal teeth. It agrees with them in having no lateral teeth, in the nature of the sinlus, and, like most of them, it comes from South America. The figure is from a paratype (Cat. No. 341473, U.S.N.M.), from a tributary of the Rio Colorado in the Province of Santander, Colombia.

## SUMMARY

1. The radiating microscopic threads may be considered a family characteristic of the Mutelidae as they appear in all the genera, with the possible exception of the genus *Mycetopoda.*

2. This characteristic, being found in Mutelidae only, is confined to naiads inhabiting Africa, South America, Central America, and Mexico.

3. Data as to breeding, anatomy, and beak sculpture of the genus *Diplodontites* being lacking, its place in Mutelidae depends upon conchological features. The radiating striae add to the number of characters which indicate that it belongs in that family.

4. The nature of the periostracum of "*Solenaia*" *falcata* Higgins shows it to be South American, as stated by Higgins, and not from southeastern Asia, as supposed by Simpson. It also shows that *falcata* belongs in the family Mutelidae, although to what genus remains undecided.

5. The genus *Mycetopoda* does not strictly conform to the usual rule so far as microscopic threads and form of shell are concerned, though its sinulus is triangular, like that of other Mutelidae.

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[4] Proc. U. S. Nat. Mus., vol. 61, 1922.

6. The sinulus and tooth of some of the shells of the genus *Pseudodon* of eastern Asia and near-by islands present a problem. It is believed that they do not indicate any close relationship of this genus to the Mutelidae.

7. The triangular sinulus, the absence of teeth, and the South American habitat of the genera *Mulleria* and *Bartlettia* of the family Aetheriidae seem to indicate some close relation of this family with the Mutelidae. The periostracum of *Mulleria* and *Bartlettia* shows no sign of radiating threads. Further study of this family with young specimens is desirable.

8. The number of striae on the shells in which a count has been made was:

| | Per millimeter |
|---|---|
| *Spatha wahlbergi* Krauss | 300 |
| *Pleiodon ovatus* Swainson | 105 |
| *Monocondylaea franciscana* Moricand | 85 |
| *Monocondylaea felipponei* Marshall | 110 |
| *Fossula fossiculifera* Lea | 105 |
| *Anondontites crispatus* Bruguiere | 80 |
| *Anondontites tenebricosus* Lea | 130 |
| *Anodontites patagonicus* Lamarck | 90 |
| *Anodontites inaequivalvis* | 100 |
| "*Solenaia*" *falcata* Higgins | 90 |
| *Diplodontites cookei* Marshall | 90 |

In conclusion it may be well to advise those who wish to make a microscopic examination of the radiating striae in the Mutelidae to begin, if possible, with *Diplodontites cookei* Marshall, then take *Monocondylaea franciscana* Moricand, and then *Anodontites crispatus* Bruguiere, passing from this to any of the other members of the family. The species mentioned will give the idea of what to look for.

## EXPLANATION OF PLATES

### PLATE 1

FIG. 1. *Anodontites crispatus* Bruguiere. At posterior portion of the disk × 30 diameters.
2. *Monocondylæa franciscana* Moricand. At the upper portion of the disk × 50 diameters.
3. *Diplodontites cookei* Marshall. At the center of the disk × 50 diameters.

### PLATE 2

All figures × 50 diameters

FIG. 1. *Monocondylaea felipponei* Marshall. Anterior to the center of the disk.
2. *Fossula fossiculifera* Lea. Anterior to the center of the disk.
3. *Anodontites patagonicus* Lamarck. Posterior to the center of the disk.

### PLATE 3

All figures × 50 diameters

FIG. 1. *Anodontites tenebricosus* Lea. At the upper portion of the disk.
2. *Anodontites inaequivalvis* Lea. On the dorsal ridge.
3. *Anodontites patagonicus* Lamarck. High up on the disk.

## PLATE 4

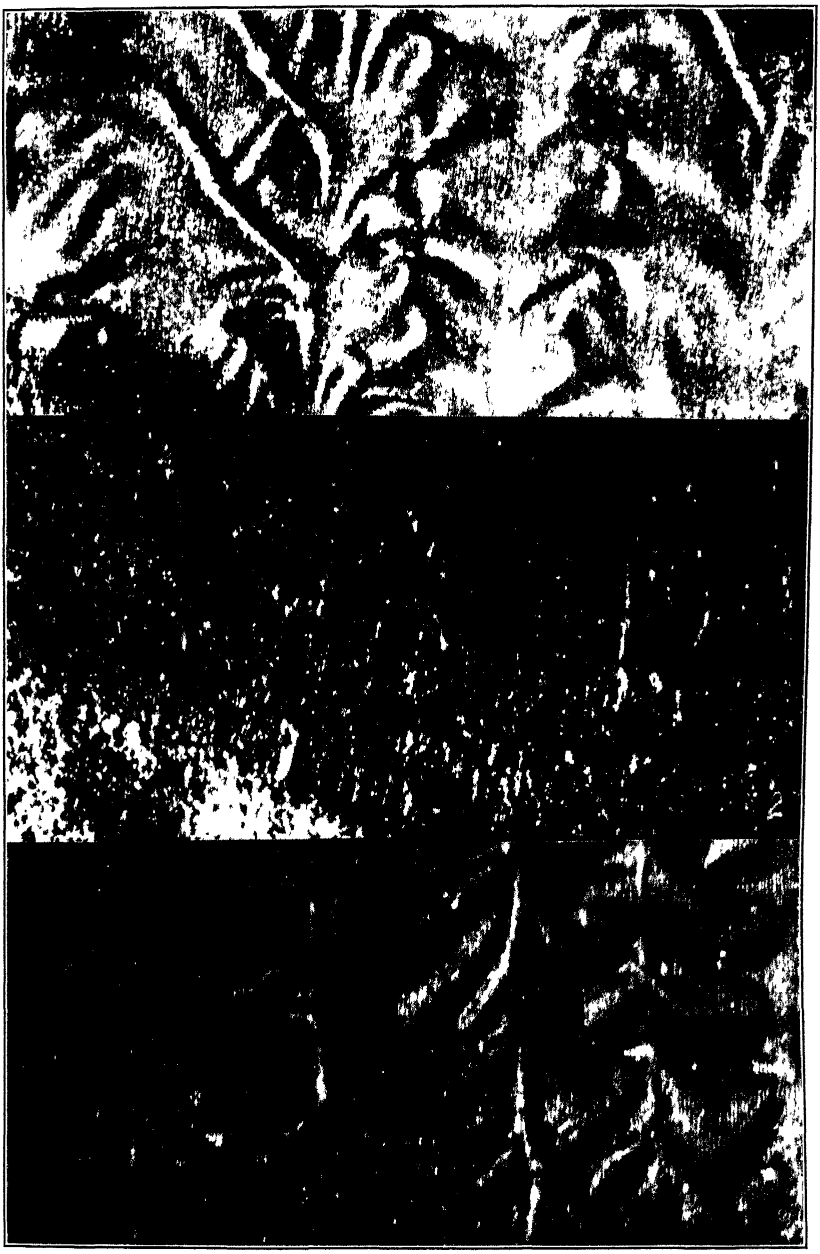
All figures × 50 diameters

FIG. 1. "*Solenaia*" *falcata* Higgins. At the posterior dorsal angle.

It would have been better if this figure could have been arranged to have the striae running horizontally and the growth lines on a slant. Being near the posterior dorsal margin, the striae, which radiate from the beak, are, at this point, nearly parallel to the dorsal edge, and nearly horizontal.

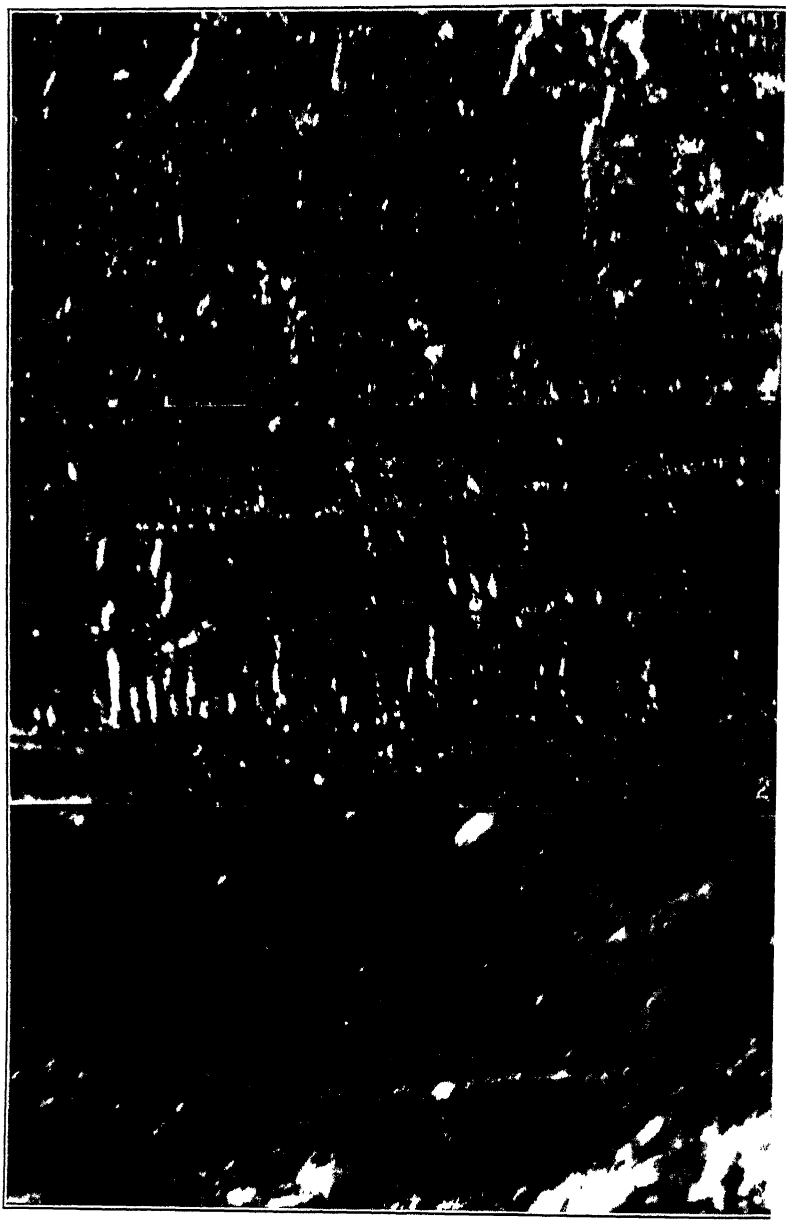
2. *Pleiodon ovatus* Swainson. Below the middle of the posterior dorsal ridge.

3. *Spatha wahlbergi* Krauss. Posterior to the center of the disk.



MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

FOR EXPLANATION OF PLATE SEE PAGE 13



MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

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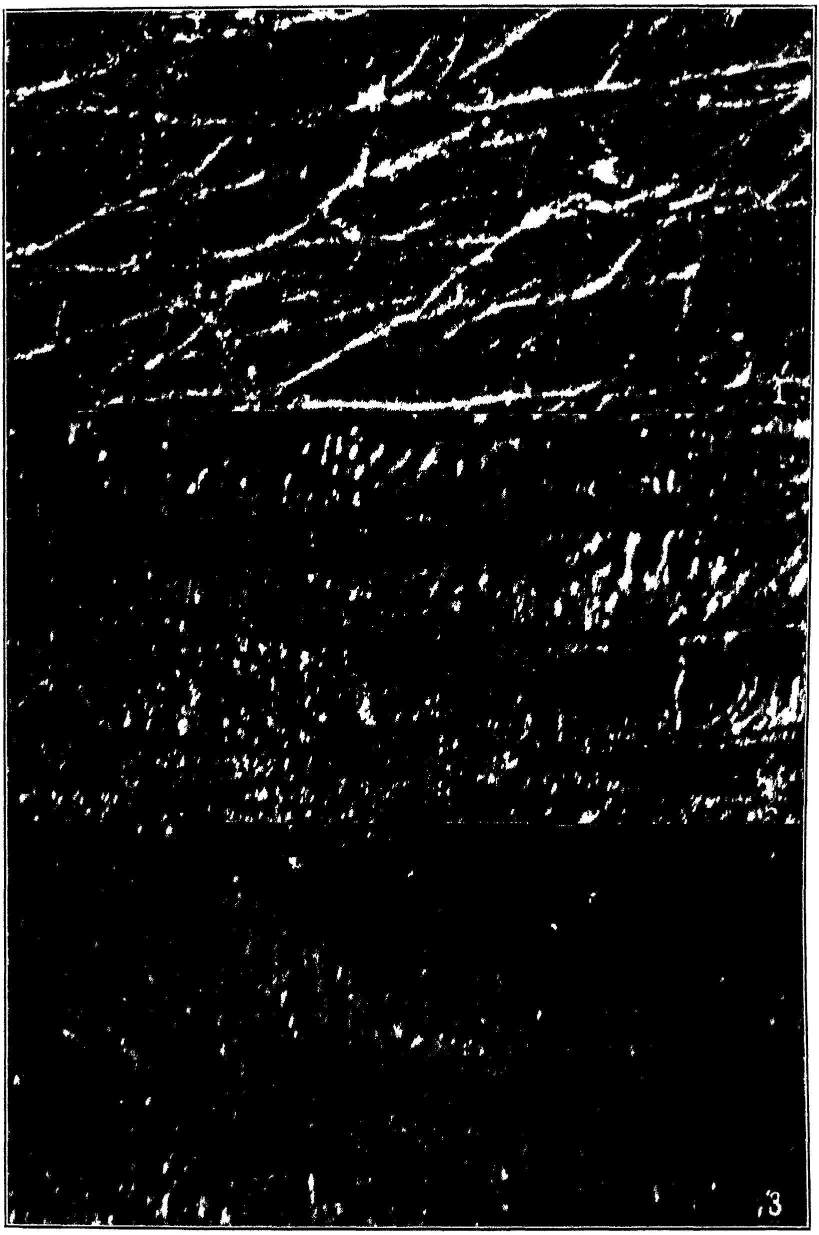

MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

FOR EXPLANATION OF PLATE SEE PAGE 13

MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

FOR EXPLANATION OF PLATE SEE PAGE 14

# THE GENUS PENTACRINUS IN ALASKA

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In April, 1913, Dr. T. W. Stanton, of the United States Geological Survey, submitted to me for examination some crinoid remains collected by field parties of the survey in the extreme northern part of Alaska, near the Arctic Ocean. These proved to belong to the true *Pentacrinus* (*Extracrinus* of Austin, de Loriol, and P. H. Carpenter) of the lower Jurassic of England and continental Europe, and of the type of *P. subangularis* Miller, from the Lias of Boll, Metzingen, Holzmaden, and other localities in Wurtemburg, Germany. I advised Doctor Stanton of this identification in a preliminary report, which was published.[1] The occurrence was of much interest as the first discovery of *Pentacrinus*, with the exception of isolated stem segments, yet made in American rocks, and because these specimens gave evidence of an unexpectedly wide distribution of one of the typical species. A detailed account of the material was deferred in the hope of obtaining more complete specimens from one of the localities, as it was then expected that Mr. Leffingwell might visit the region again. Nothing further has been accomplished, however, and it has been thought advisable to proceed with what we have.

The material in hand comes from two localities. The first is on a small island called Black Island, in Canning River, opposite Mount Copleston, longitude 146° 20′ W., latitude 69° 30′ N.; it is about 100 miles above the mouth of the river where it debouches into the Arctic Ocean near Flaxman Point. Here a single specimen was secured, consisting of a small slab containing crinoid remains brought from the island by a native. It was derived from a formation composed of about 4,000 feet of shale called the Kingak shale, correlated by Mr. Leffingwell as of lower Jurassic age.[2] The specimen consists of part of a set of arms of a large individual, probably associated with numerous others, in a preservation so exquisite as to induce a strong desire to secure further treasures from the locality. Although wonderful specimens of the species to which this probably belongs have been obtained in various European localities—one of the finest being on exhibition in the hall of Invertebrate Paleontology in the United States National Museum, having complete arms 15 inches long, and 5 feet of stem attached—none of them exhibit such perfection in fine structural details as this, especially in the sharp definition of the pinnules, as shown by the figure herewith. The condition of this specimen indicates that it was part of a considerable colony, in which a large number of these crinoids were imbedded together, as is the case at some of the European localities.

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[1] Professional Paper 109, U. S. Geol. Surv., 1919, The Canning River Region, Northern Alaska, by Ernest de K. Leffingwell, p. 119.

[2] Idem, p. 119.

The second locality is about 125 miles east of the first, near the international boundary line, on a tributary to Overthrust Creek, 1¾ miles above its mouth, and about 8 miles west of the one hundred and forty-first meridian. A. G. Maddren, while engaged in geological investigations along the Canada-Alaska boundary during 1911 and 1912, found at this locality a crinoid bed composed of fragments of the same *Pentacrinus* as the Black Island specimen, in a formation largely made up of black shales which are probably the equivalent of the Kingak shale.[3] These remains consist of numerous column and arm fragments of large size, rather closely packed together, indicating a bed of considerable extent, in which, however, the specimens lack the fine preservation of that of locality 1. The matrix is highly ferruginous, with much oxidation at the surface by which the structural details are destroyed, except in some of the column fragments, which have the joint-faces well preserved, showing the petaloid sectors characteristic of the genus.

There is a general similarity in size and appearance of the parts recovered from the two localities, which indicates the probability of their being of the same species. They are larger than the corresponding parts of specimens as usually found at Lyme-Regis in Dorsetshire, England, but not of greater size than that of many specimens from the Wurtemburg localities.

Among Mesozoic crinoids no genus has attracted more attention, both in the literature and in the rocks, than *Pentacrinus* of the lower Jurassic. From what has been learned in recent years, it probably had a wider distribution than any other. In view of this fact, and of the evidence as disclosed by the material now before us of its great abundance in a region where it was least expected, I have thought it well, for the benefit of those who may not have convenient access to the publications, to give a brief summary of the leading facts relative to the genus. The chief descriptive matter may be found in the works of J. S. Miller, Quenstedt, de Loriol, and P. H. Carpenter; but for a comprehensive and lucid exposition of the genus and the complications relative to it, the reader should consult Bather's paper on "Pentacrinus, a Name and a History."[4]

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[3] Leffingwell, same reference, p. 120.

The name is involved in considerable confusion, and students are apt to be misled by the manner of its use in the literature at certain periods. The two principal species were described by J. S. Miller in his Natural History of the Crinoidea, 1821, as *Pentacrinus briareus* (p. 56, pls. 1 and 2) from the lower Lias, and *P. subangularis* (p. 59, pls. 1 and 2) from the middle or upper Lias. It is evident from Miller's descriptions that he had as types specimens from the typical localities: *P. briareus* from Lyme-Regis, Dorsetshire, England, and *P. subangularis* from the black slate in Wurtemburg, Germany. He credits *subangularis* also to Lyme-Regis, and de Loriol refers a specimen from France to that species; while Quenstedt describes several varieties of *P. briareus* from Wurtemburg localities; but it is open to question whether the two forms are not chiefly confined in Europe to their respective localities and horizons. There is some confusion in the descriptions as to horizon; *subangularis* is credited to both the middle and upper Lias, and *briareus* to upper and lower.

These two most common species in the Lias of England and Germany are extremely abundant, often composing entire strata, in which their remains are beautifully preserved, furnishing most striking specimens, which are to be seen in nearly all museums.

The name *Pentacrinus* as employed by Miller included two types: 1, in which the radials project downward over the proximal columnals, and the arms are heterotomous; and 2, in which the radials do not so project, and the arms are dichotomous. The name was also applied to the earlier described stalked crinoids of the present seas, such as *P. caput-medusae*, *P. mulleri*, *P. wyville-thomsoni*, *P. decorus*, etc. Then the Austins in 1848 proposed to separate the species of type No. 1 under a new genus, *Extracrinus*, leaving only those of No. 2 under the original name. This course was followed by de Loriol[5] and by P. H. Carpenter in the *Challenger* Report on the Stalked Crinoids, and the names were applied by them accordingly.

Later on it was discovered that the *Pentacrinus briareus* of Miller, which had been illustrated under the name of the Briarean Pentacrinite by Parkinson in 1808[6] and of which Miller's name had been copied into treatises and textbooks generally,[7] was the identical species which had been described by Blumenbach in 1802 from a specimen from Dorsetshire as *Encrinites fossilis*, and as *Pentacrin-*

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[4] Natural Science, vol. 12, 1898, p. 254.
[5] Crinoides de la France, vol. 2, 1868, p. 385.
[6] Org. Rems., vol. 2, p. 248.
[7] Dana's Manual of Geology, ed. 4, p. 778.

*ites fossilis* in 1804.[8] Under the rules of nomenclature this name had priority, and Miller's name would have to be discarded in its favor. Not only so, but as the name *Pentacrinus* had been attached to the (*briareus*) *fossilis* type, No. 1, long before the time of the Austins, it followed that their genus *Extracrinus* must also go into the discard, and all the species which had been ranked under it would now have to be listed as the true *Pentacrinus*.

Furthermore, it was found that the *Pentacrinus* type No. 2 was covered by the genus *Isocrinus* Agassiz, 1836 (von Meyer, 1837); so that the species of that type, which included all the Recent "*Pentacrinus*", would have to be written *Isocrinus*, leaving the species of type No. 1 as the true *Pentacrinus*, typified by Blumenbach's original species, *P. fossilis*.

All this history, of which I am giving but a brief abstract, will be found fully set forth with ample reference to the original sources, in Doctor Bather's paper already mentioned. Thus when in the literature the name *Pentacrinus* is encountered for an existing crinoid, or for a fossil species in the works of de Loriol, it means *Isocrinus;* and where the name "*Extracrinus*" occurs it should be read *Pentacrinus*. And for the classic name "*Pentacrinus briareus*" there should now be substituted *P. fossilis*. Quenstedt did not adopt the name "*Extracrinus*," but continued to use the original term for both forms.

With this explanation to obviate confusion over the names, we are in position to consider the questions relating to the particular forms of the genus suggested by the new material.

According to Quenstedt and de Loriol[9] the true *Pentacrinus* (type No. 1, above) is divisible into two groups, characterized by stem characters only, which with our present knowledge would be described as follows:

1. *P.* (*briareus*) *fossils* (Blumenbach), 1802. Lower Lias, Dorsetshire, England.

Stem short, sharply pentagonal. Columnals alternating, but not strongly unequal. Internodals few, from 1 near the calyx, to 3 or 4 distally. Cirri large, very long, prismatic or flattened, in whorls of 5 to every nodal.

2. *P. subangulrais* Miller, 1821. Upper and middle Lias, Wurtemburg, Germany.

Stem very long, subpentangular or round. Columnals alternating, very unequal; internodals numerous, increasing from the calyx distalwards by doubling. Cirri few, small, short and round.

In a good specimen from Holzmaden in my collection the cirrus intervals increase from 3 ossicles (1 long and 2 short) beginning with the second large columnal near the calyx, to 7, 15, and 31 internodals at about the fifteenth internode, a distance of about 30 cm.; the increase is by interpolation of new internodals, which continues progressively further down along the stem, the interpolated columnals appearing at the surface in the form of short and thin lacunae, which gradually widen and coalesce until they become full columnals, and these increase in length until they approach the size of those adjoining them. So the next increase would be to add 32 young thin ossicles to the internode, making 63 in all at about the twenty-fourth internode.

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[8] Abh. Naturh. No. 70, pl. 70.

[9] Crin. de la France, vol. 2, p. 385.

Thus the progression would be about like this:

| | |
|---|---|
| Internode 1 has 1 long, 2 short | 3 |
| Internodes 2–5 have 1 long, 2 short, 4 lacunae | 7 |
| Internodes 6–10 have 3 long, 4 short, 8 lacunae | 15 |
| Internodes 11–17 have 7 long, 8 short, 16 lacunae | 31 |
| Internodes 18–25 have 15 long, 16 short, 32 lacunae | 63 |

Both groups are cited from Wurtemburg, but apparently only *P. fossilis* from England. De Loriol gives a list of the species in the two groups, and declares that as to those occurring outside of France they have not been described with sufficient exactness to enable him to recognize them. And the same may be said of most of those from France. In fact the literature is encumbered with the names of more than a hundred species of *Pentacrinus*, most of them without definition by which they can be recognized. They have been proposed chiefly upon isolated stem-ossicles, which differ much in contour and markings according to their position in the stem. Outside of the common species the characters are not well known, and nothing short of a thorough revision of all species based upon the type and associated material will afford the knowledge necessary for comparison.

The specimens from Alaska without doubt belong to the second, or *subangularis*, group. The round column, and strong alternation of columnals as they appear in figure 2 of our plate, establish this conclusively. Enough is visible in the lateral views of the few short stem fragments exposed to show that the internodal columnals merge in the form of lacunae, as shown by figure 4, and as further explained in my paper on *Pentacrinus rotiensis* from the East Indies.[10]

No cirri are observable on the parts preserved. The sculpture of the numerous joint-faces exposed on figure 2 is precisely of the type of the Wurtemburg specimens, as figured in the above-mentioned paper (pl. 1, figs. 3, 4, and herein, fig. 3). But there is to be seen a slight difference in the outline of the columnals, that of the latter being distinctly subpentagonal, while those of our specimens are almost uniformly round, a difference which may be due to different positions in the stem.

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[10] Nederlandische Timor-Expeditie II. Jaarboek van het Mijnwesen, 45e Jaargang, 1916, Leiden, Holland. Published in 1918.

The set of arms shown in the Black Island specimen (fig. 1) are also clearly of the *subangularis* type. The brachials are slightly wedge-shaped, giving off a pinnule from the longer side of each, both on the main arms and the ramules, so that as seen from either margin the pinnules are borne alternately on every second brachial. Their form and proportions, as well as the exquisite delineation of details, are clearly brought out in the photograph. One notable item is the very large size of the first pinnular, which articulates with two brachials. Some of the pinnulars show notches or crenulations on the ventral edges.

In size there is not much difference between our specimens and the average of those from Wurtemburg. Compared with good-sized specimens from Holzmaden, as figured in Quenstedt,[11] we have the following details:

| | Alaska | Wurtemburg |
|---|---|---|
| | *Mm.* | *Mm.* |
| Diameter of column | 6–12 | 12, 13, 15 |
| Width of arm in lower division | 7 | 7 |
| Number of brachials in interval between ramules | 13–14 | 13 |

With the foregoing facts to go on, there would seem to be no good reason for separating the Alaskan form specifically from *subangularis*. Yet in order to allow for probable migrational changes not disclosed by our incomplete material, and for more convenient designation in the literature, I think best to give it a varietal name, *Pentacrinus subangularis*, var. *alaska*, which will have at least as good ground to stand on as any of the five varieties based on Wurtemburg specimens into which Quenstedt undertook to subdivide the species *P. briareus*, to say nothing of the doubt, before mentioned, whether the type of the (*briareus*) *fossilis* group occurs in that area.

Wishing to have the benefit of the fullest information before finally recording my own impression, I sent copies of my figures to Dr. F. A. Bather, requesting him to compare them with the specimens in the British Museum, and to favor me with his opinion. This he has very kindly done, and given me a report from which I quote the following extract:

LONDON, *25 May, 1923.*

DEAR MR. SPRINGER: I have examined your photographs of *Pentacrinus* from Alaska with great care, comparing them with the published descriptions, and with the material in this museum from Dorset and Wurtemberg. The only difference I can see is that the few stem fragments visible from the side do not show such marked or regular alternation in the sizes of the columnals as do all the specimens in this museum. This may depend possibly on the region of the column from which they came, and in any case the evidence of the photograph is not very extensive. The photograph of the arms shows the pinnules much better preserved than any specimens we have here. The ventral edges of some of the pinnulars show about four notches or crenulations. I am unable to detect these in any of our specimens, but the material is insufficient. I should certainly refer these specimens to *P. subangularis* in the broad sense. Quenstedt, you will remember, confessed that his attempts to divide up that species were not very satisfactory to him.

Perhaps the most interesting feature of the Alaskan discovery is its bearing upon the geographical distribution of this vigorous Jurassic crinoidal type, which now appears to have spread into almost all waters, and to have flourished in great profusion in regions remote from each other. Isolated stem-ossicles from Dakota and from Utah described as *Pentacrinus asteriscus* by Meek and Hayden,[12] and as *P. whitei* by W. B. Clark, show a still wider spread upon the American continent. And when we consider the further evidence now in hand of the existence of a closely related form in the East Indian archipelago, as given in my paper before cited, we are impressed with the cosmopolitan range of the genus, far exceeding that of any crinoid of the present ocean. It is a good illustration of the result of conditions prevailing in the Jurassic and Cretaceous periods of deep and clear seas, which were favorable to the development and spread of marine faunas over large areas with a minimum of checks and interference, in contrast to those of subsequent periods down to the present, in which owing to the great changes in land form affecting the conditions of marine life, and to increasing competition arising from the multiplication of forms, the tendency has been toward progressively greater restriction of faunal areas.

## EXPLANATION OF PLATE

*Pentacrinus subangularis* var. *alaska*, new variety

FIG. 1. Part of a set of arms, with ramules and pinnules finely preserved. Natural size. U. S. National Museum. Black Island, Canning River.

2. A small slab filled with stem-fragments, many showing the joint-faces in detail, and some in side view showing the very unequal columnals with interpolated lacunae. Natural size. U. S. National Museum. Overthrust Creek, near international boundary.

Lower Jurassic, Kingak shale; northern Alaska.

*Pentacrinus subangularis* Miller

3. A typical joint-face, enlarged, for comparison of structures. ×2. Author's collection.

Lower Jurassic. Upper Lias; Boll, Wurtemburg.

*Pentacrinus rotiensis* Springer

4. A stem-fragment containing a complete internode of seven pairs of internodals, to show the mode of growth of younger ossicles by interpolation in the form of small lacunae not yet meeting at the exterior to form a complete columnal. Collection Dr. G. A. F. Molengraaff, Delft, Holland.

Jurassic. Island of Roti, Dutch East Indies.

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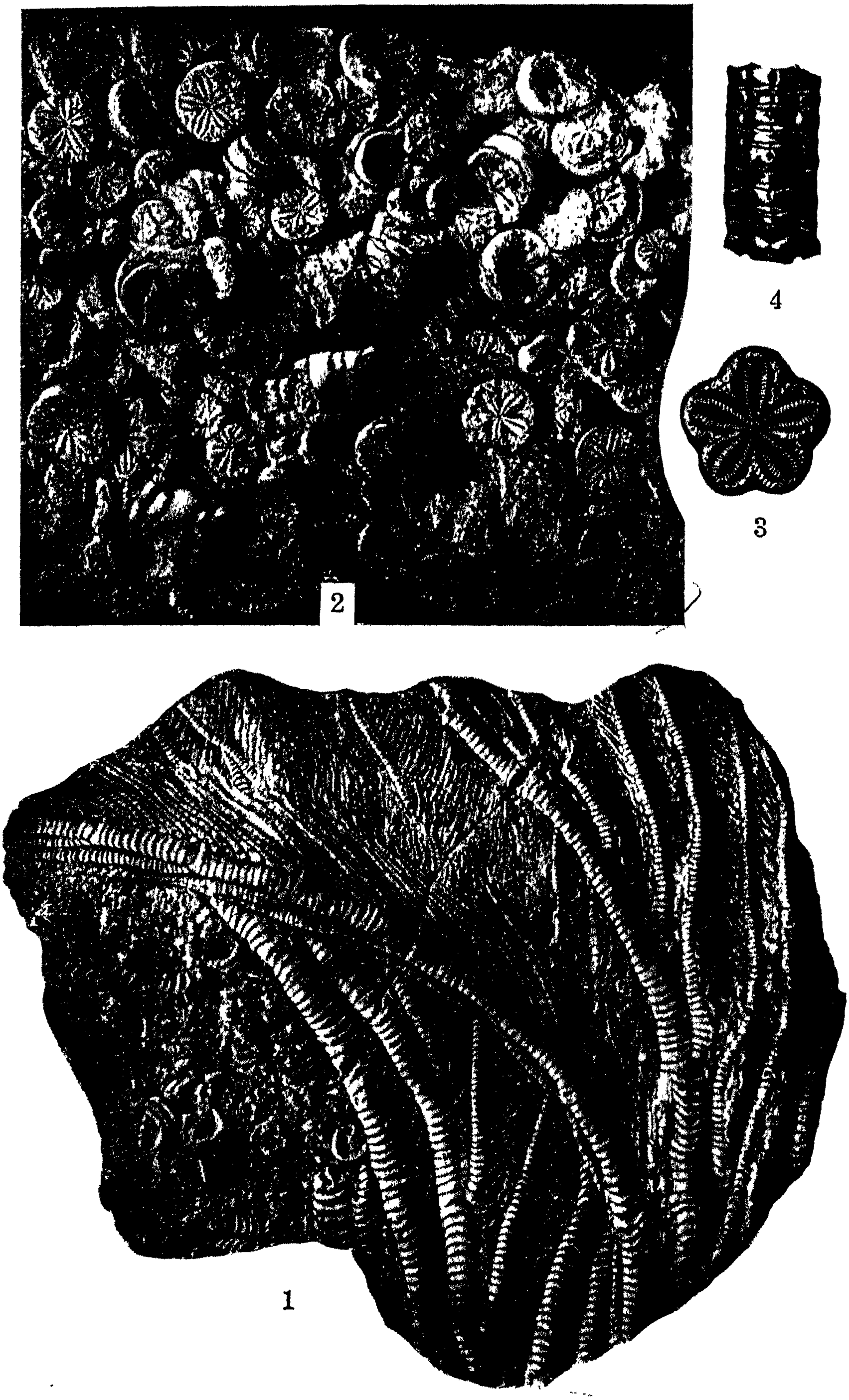
[12] Pal. Upper Missouri, 1865, p. 67, pl. 3, figs. 2, *a–b*.



THE CRINOID GENUS PENTACRINUS IN ALASKA

FOR EXPLANATION OF PLATE SEE PAGE 7

# A NEW METEORIC STONE FROM BALDWYN, MISSISSIPPI

By George P. Merrill

*Head Curator of Geology, United States National Museum*

At the time of the meeting of the Geological Society of America in Washington, December, 1923, the present writer was shown by Prof. L. C. Glenn, of Vanderbilt University, Nashville, Tenn., a beautifully encrusted meteoric stone weighing about 345 grams, which fell on the farm of Allen Cox, of Baldwyn, Miss., February 2, 1922. Concerning it Mr. Cox furnished the writer the following information:

> This meteoric stone fell * * * on my farm about one and a half miles northwest of Baldwyn, Miss. Ed. Bush, a negro tenant on my place, who is an unusually reliable and intelligent darky saw it fall and in fact it did not miss hitting him by more than 10 feet. He came to the house and reported it to me and I went with him and picked up the stone which had buried itself about three or four inches in soft clay. It was still hot, not hot enough to burn, but very decidedly warm and gave off a smell very much like brimstone or a flint when it has been struck with steel and sparks have been made to fly. The darky had been so badly scared that he had been afraid to touch it. He said his attention was first attracted by a humming noise which he took to be an airplane and he turned to look into the sky for the airplane but saw nothing. The noise increased and in a short space of time described by him as about a minute, but which I am sure was only a few seconds, a rush of air came by his head and the stone buried itself near his feet. He did not at any time see the actual stone until it hit the ground. It first was heard in a northwesterly direction from him and in falling described an arch of about 30 to 35 degrees as nearly as I could tell from the location he gave me for the position of the first sound.

As no record of this stone has thus far appeared in print, the present writer, with Professor Glenn's permission, cut from it a thin section from which the following description was prepared:

The stone is chondritic though the structure is quite indistinct. The single thin section examined shows the usual fine granular ground with irregularly outlined areas of larger granules, the evident residue of chondrules partially obliterated through metamor-

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22259—25

phism. The determined silicate minerals are olivine and an orthorhombic pyroxene with small, interstitial areas of a clear, colorless, doubly refracting mineral which in a few instances shows plainly the twinning striae characteristic of a plagioclase feldspar. The cut surface shows numerous black veins, some of which are mere lines, but in one instance 4—5 millimeters in diameter enclosing fragments of the silicates, the whole imparting a somewhat breccia structure to the stone (see pl. 1).

Under the prevailing system it would be classified as a veined white chondrite.

This stone, the doubtfully meteoric iron of Oktibbeha and a small stone that fell near Palahatchie in Rankin County on October 17, 1910, represent the sole contributions of the State of Mississippi to our knowledge of the distribution of these very interesting bodies.

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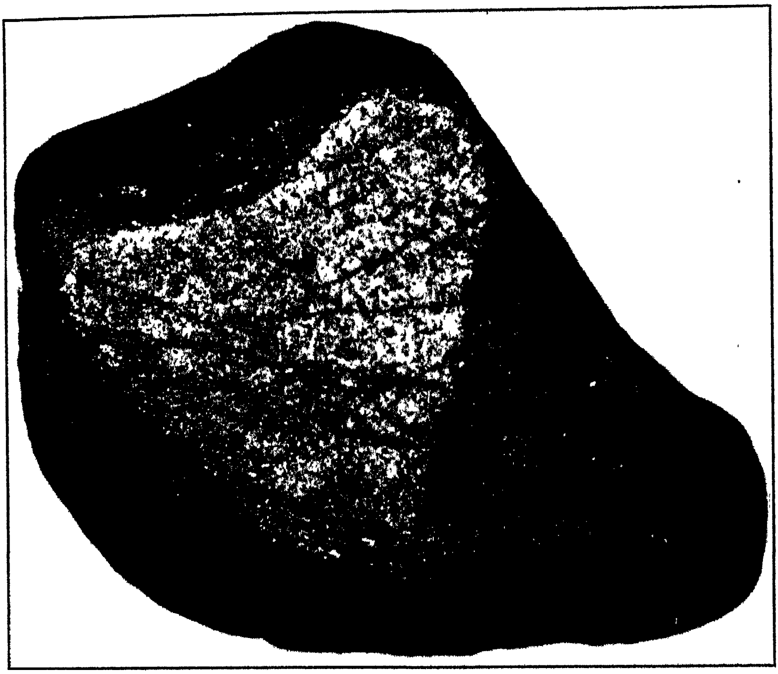

THE BALDWYN, MISSISSIPPI, METEORIC STONE

FOR REFERENCE TO PLATE SEE PAGE 2

# THE ORIGIN, OCCURRENCE, COMPOSITION, AND PHYSICAL PROPERTIES OF THE MINERAL IDDINGSITE

By Clarence S. Ross
*Geologist, United States Geological Survey*
and
Earl V. Shannon
*Assistant Curator of Geology, United States National Museum*

## INTRODUCTION

Dr. A. C. Lawson,[1] while studying the volcanic rocks in the vicinity of Carmelo Bay, Calif., in 1893, found an undescribed mineral in the rocks called carmeloites, to which he gave the name iddingsite; that, however, the mineral was a distinct species was not generally recognized and it is still described in the textbooks as a variety of serpentine.[2] Subsequent study has shown this to be a widespread and, at times, an abundant mineral in basaltic rocks, but its chemical composition and real nature have long remained matters of speculation. It is a secondary mineral, rarely entirely free from the olivine from which it is derived; it is rather finely disseminated among other minerals of nearly the same specific gravity, and so investigators have been deterred from making the tedious efforts required for its separation and analysis.

The chemical portion of the following paper is based upon eight analyses of iddingsite from six localities, and while the results of these analyses do not give a complete understanding of the chemical composition of iddingsite, they show that it is not serpentine and establish it as a distinct mineral species. All the analyzed iddingsites, and additional materials from widely separated localities from the western United States, have been examined; the physical properties have been determined; its relations to the associated minerals have

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[1] Lawson, Andrew C., Univ. of Calif. Bull. of Dept. of Geol., No. 1, p. 31, 1893.

[2] Johannsen, Albert, Determination of rock-forming minerals, p. 361, New York, 1908. Iddings, Joseph P., Rock minerals, p. 381, New York, 1911. Winchell, N. H., and A. N., Elements of optical mineralogy, p. 360, New York, 1909.

No. 2579.—Proceedings U. S. National Museum, Vol. 67, Art. 7.
23555—25——1

been studied; and conclusions as to the genesis of iddingsite have been reached. This paper is presented in the belief that the available data on the composition, and a detailed study of the origin of this long discussed mineral will prove to be of interest, as the results are distinctly at variance with previous views about iddingsite.

## REVIEW OF PREVIOUS INVESTIGATIONS OF IDDINGSITE

In a discussion of the rocks of the Eureka district, Nevada, Iddings[3] says of the mineral later named iddingsite: "There commences from the surface and from fractures (in olivine) as in the ordinary process a fibration, not in directions always normal to the surface, but in lines parallel throughout the crystal, and parallel also to some direction in the plane of the more perfect cleavage. The fibers have a light yellow color at first, which deepens into a reddish brown or blood red as the decomposition proceeds; they polarize light brilliantly and show parallel extinction and sometimes faint pleochroism. The resultant mineral is evidently not a compound aggregate, but a crystallographic individual, with parallel orientation in all its parts, for the extinction of light is the same throughout, and the interference figure is that of a doubly refracting crystal." Iddings observed occasional well crystallized hexagonal plates in the less altered olivine and found that on treatment with hot concentrated hydrochloric acid the mineral lost color without changing its optical properties. This induced him to think that: "The substance is in this case a nearly colorless micaceous mineral, colored red by iron oxide." He concludes:

> That the mineral is a foliated, crystallized form of serpentine seems probable from the fact that most of the basalts are so fresh, with the decomposition of the olivine frequently confined to the weathered surface, that a very radical change is not likely to have taken place, and that simple hydration and oxidation of a very ferruginous olivine would supply all the chemical elements necessary to transform it into anhydrous unsilicate of magnesia and ferric iron; besides which is the fact that the optical properties of the mineral in question correspond to those given by Miller for thermophyllite.

Describing the "Potlach pseudomorphs after olivine" in the Carboniferous tuffs and dolorite of Derbyshire, Arnold-Bemrose[4] says:

> The plane of the optic axes is at right angles to the length of the original crystal, the angle between the optic axes is very small, and the double refraction negative. As a rule the pseudomorphs behave as a crystallographic individual, and not as an aggregate. The traces of the cleavage are generally parallel to the length of the crystal. * * * When mounted, the thin flakes appear brown or brownish-yellow by transmitted light. In convergent light they show a biaxial figure, with a small angle between the axes and negative double refraction. They are sometimes almost uniaxial. When a fragment does

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[3] Iddings, Joseph P., Appendix B, Mono. 20, U. S. Geol. Survey, pp. 388–390, 1892.

[4] Arnold-Bemrose, H. H., Quart. Journ. Geol. Soc., p. 603, London, 1894.

not lie on the cleavage plane it shows dichroism, the greatest absorption taking place when the short axis of the polarizer is parallel to the trace of the cleavage.

In his investigation of iddingsite, Lawson[5] made qualitative chemical tests and says:

> Chemically therefore iddingsite is a hydrous nonaluminous silicate of iron, magnesia, and soda. * * * The extraction of iron by acids without decomposition of the mineral indicates that a considerable proportion of that element is present, not as a part of the silicate molecule, but as a pigment in the form of hematite or limonite, probably the latter.

Of the optical properties Lawson says:

> Under the microscope the cleavage plates prove to be biaxial, and yield with great definiteness a figure which shows that the plane of the optic axis is at right angles to the cleavage and parallel to the $c$ axis, and that the acute bisectrix is perpendicular to the cleavage, being coincident with the $a$ axis. In these plates and in all sections transverse to the cleavage in the slides the extinction is strictly parallel to the cleavage, to the fibrous structure, and to the trace of the pinacoids. This shows that the three axes of elasticity are parallel to the three crystallographic axes, respectively, and that the mineral is therefore orthorhombic. * * * In thin section iddingsite becomes transparent in colors which range from a deep chestnut brown to citron yellow, or occasionally a clear greenish yellow. The pleochroism is strongly marked in sections transverse to the cleavage, particularly so in those parallel to the axial plane, but usually very feeble in sections parallel to the cleavage. The absorption formula is $\mathfrak{c}>\mathfrak{b}>\mathfrak{a}$.

The double refraction (not given) low. The other properties determined by Lawson may be summarized as follows: Hardness 2.4; Specific gravity variable, maximum 2.893; Infusible before the blowpipe, and not perceptibly altered. Yields water in the closed tube. He concludes:

> It is evidently not the form of crystallized serpentine thermophyllite, since it differs from the latter in physical appearance, in behavior before the blowpipe, in density, in luster, and in color; neither does it correspond optically with serpentine. Moreover, the development of serpentine from olivine by hydration is accompanied by a swelling of the mass. In the case of iddingsite, on the contrary, there is very frequently excellent evidence of shrinkage. * * * There appears to be no good reason for regarding the mineral as a crystallized variety of serpentine.

Ransome[6] studied iddingsite in the eruptive rocks of Point Bonita and has the following to say of the mineral:

> Iddingsite is present in many of the slides of the diabase, in rounded ideomorphic crystals of various sizes up to about 2 millimeters in length, whose outlines are strongly suggestive of olivine. The color varies from light greenish yellow to dark dingy green. * * * These sections are pleochroic, being dark yellowish green parallel to the cleavage, and light greenish yellow at right angles to that position. Under crossed nicols the undecomposed portions show brilliant mottled polarization colors, crimson and green predominating,

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[5] Lawson, Andrew C., Univ. of Calif. Bull., Dept. of Geol., No. 1, pp. 31–36, 1893.

[6] Ransome, F. L., Bull. Dept. Geol., Univ. Calif., No. 1, pp. 90–92, 1894.

and the double refraction is therefore strong. The mean index of refraction (not given) is rather low. The distinctly terminated prismatic sections are but slightly pleochroic and show no cleavage. The interference colors are moreover low. In general they give a distinct biaxial figure, with a small angle. * * * The plane of the optic axes lies parallel to the longer axis of the prism, and is, therefore, perpendicular to the cleavage planes. * * * The mineral was ascertained to be optically negative.

## OCCURRENCE

Iddingsite is widely distributed in the basaltic rocks of the San Juan region of southern Colorado and northern New Mexico, and, indeed, throughout the western United States. Petrographic studies[7] of these rocks show conclusively that the red or red-brown alteration product of olivine is not serpentine and indicate that it is a definite mineral as suggested by Lawson.

Iddingsite nearly always gives clear evidence of its derivation from olivine, since the outlines of the original olivine crystals are often beautifully preserved. All degrees of alteration have been observed from perfect, homogeneous crystals of iddingsite to olivine crystals with the merest film of iddingsite between cleavage cracks. Usually the outer zone is changed to iddingsite where the alteration is incomplete, but in one large group of rocks the central area is usually iddingsite with an outer zone of fresh olivine. The manner of alteration appears to depend upon some property inherent in the original olivine itself, which allows some parts to be more easily altered than others. Much of the iddingsite seems at first glance to be fibrous, and it has been so described. Close study, however, shows that this effect in the material investigated is the result of minute inclusions of spinels, magnetite, or hematite. High magnifications of small grains of iddingsite reveal a clean fracture with no indication of fibers. The photomicrographs in Plates 1 and 2 show the relationships between olivine and iddingsite in a number of different rocks. In many specimens (pl. 1, fig. 1, and pl. 2, fig. 4), there is an outer zone of iddingsite surrounding a core of olivine with a ragged area between the two, with shredlike masses of iddingsite extending into the olivine. In other specimens (pl. 1, figs. 3, 4) there is alteration along cracks in the olivine with the same shredlike masses of iddingsite extending into olivine. In some specimens (pl. 1, fig. 3) there is an outer zone of iddingsite around olivine with a sharp contact between the two. In many specimens the large phenocrysts are completely changed to iddingsite, while small groundmass grains of olivine of a later generation show little alteration. In one large group of rocks (pl. 1, fig. 3; pl. 2, figs. 5, 6) there is an inner core of iddingsite surrounded by fresh olivine. In some specimens (pl. 1, fig. 4) alteration has occurred along cracks with very sharp contacts between iddingsite and olivine. Much of the iddingsite investigated contains very small grains of magnetite and other spinels arranged in minute lines parallel to the crystallographic axes of the mineral.

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[7] Larsen, Esper S., Bull. 679, U. S. Geol. Survey, p. 90, 1921.

A pale brown or yellow material is associated with iddingsite in some rocks and this material is represented by analyses 3 and 5. This is usually cryptocrystalline and has a lower index of refraction than normal iddingsite and a small axial angle where it is possible to determine it. It forms a rim around iddingsite in some specimens and a core in others. The contact between the two types of material is sharp in some specimens and transitional in others. The evidence does not clearly indicate whether this pale material is impure, imperfectly crystallized iddingsite or a different but closely related mineral.

Usually there is evidence that there was a very marked loss of volume during alteration of olivine to iddingsite, as the cleavage planes (pl. 2, fig. 1) are marked by widely gaping cracks that occupy 10 to 20 per cent of the volume of the original olivine.

## ORIGIN

Iddingsite has usually been described as a weathering product of olivine. Its origin through the processes of weathering can not be summarily rejected for all occurrences, but in the material studied in the preparation of this paper an origin through weathering seems to be extremely improbable. In the basaltic rocks of southern Colorado and northern New Mexico there is no observable relation between the occurrence of olivine or iddingsite in a rock and the amount of weathering that rock has undergone. In general, there is little weathering in these rocks and iddingsite occurs in the freshest of them, in association with unaltered augite, feldspars that are not even clouded, and basaltic glass (a very unstable material) that is unchanged. It has been observed evenly distributed from top to bottom of a basaltic sill 50 feet in thickness where no trace of weathering could be found. Its occurrence bears no relation to exposure of surface, proximity to joint cracks or relative age of the various beds. It may be abundant in one flow and be absent in any one or all of either higher or lower flows of a series. Several flows have been identified where iddingsite of similar characteristics is present over very wide areas, showing that the characteristics of the iddingsite are inherent in the rock.

In rocks that do show extensive alteration, serpentine and not iddingsite has developed from olivine. Some basalts show a narrow leached zone at the surface, and here impure amorphous aggregates of hydrous iron oxides have formed from the olivine crystals and not iddingsite.

In many of the rocks studied the relation of fresh olivine and iddingsite present pecularities that appear to give a clew as to the mode of origin. The presence of small grains of ground-mass olivine remaining nearly fresh in the presence of large phenocrysts that have been completely changed to iddingsite suggests that the processes involved in the change are partly dependent on the original composition of olivine. The basalt of the Hinsdale volcanic series of the Rio Grande Valley of northern New Mexico has been traced for 80 miles, and wherever observed it shows cores of iddingsite surrounded by fresh olivine (see pl. 1, fig. 2, and pl. 2, figs. 5, 6). Similarly, rocks from many other sources show a very distinct zonal relationship in the development of the iddingsite. It seems very difficult to explain such relationships on the basis of weathering, especially as these phenomena are characteristic of single flows or single groups of flows over wide areas. On the other hand, these facts suggest very strongly that the alteration was partly dependent upon zonal variations in the original olivine from which the iddingsite was derived. This led to an investigation of the olivines of iddingsite-bearing rocks. The basalt of Cerro Mohera, New Mexico, is of the same age and type as that giving rise to the sharp zones of olivine around iddingsite shown (pl. 1, fig. 2, and pl. 2, figs. 5, 6), but is itself little altered. A careful study of the optical properties of this olivine showed that the index of refraction for $\beta$ varied from $n=1.711$ to $n=1.722$, and the optical character varied from + to −, indicating an appreciable variation in the proportion of iron silicate ($Fe_2SiO_4$) in the olivine molecule. These facts, supported as they are by the mineral relationships, seem to show that the formation of iddingsite from olivine is partly dependent upon the chemical composition of the olivine.

Iddingsite is confined almost exclusively to extrusive or hypabyssal rocks and is practically absent from deep-seated rocks, but if iddingsite were derived from olivine by ordinary weathering there is no reason why it should not occur in abyssal rocks. The restriction in occurrence shows that specialized conditions are required for the formation of the mineral and that these conditions are most often realized in a cooling extrusive. This restriction in occurrence and the relationships described indicate that the development of iddingsite is definitely associated with magmas that cooled near the surface.

In discussing iddingsite, Iddings[8] says:

> There remained in the portion (iddingsite) subjected to acid, well developed, nearly opaque octahedrons, most likely picotite.

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[8] Iddings, Joseph P., U. S. Geol. Survey, Mono. 20, p. 390.

Ransome[9] says:

> It (iddingsite) includes abundant grains of iron ores, and frequently dark brown microscopic crystals of chromite or picotite. * * * In the Point Bonita iddingsite the limonitic pigment is entirely absent.

The writers have found very large amounts of magnetite in the iddingsite from Race Creek, Colo., and spinels in that from Brazos River, N. Mex. Small amounts of magnetite or related minerals seem to be almost always associated with iddingsite. These associated minerals that have clearly developed by the same processes as iddingsite contribute a very convincing line of evidence that iddingsite is not the result of ordinary rock weathering. Weathering would produce hydrous iron oxides probably in the form of limonite and would be very unlikely to yield magnetite and other minerals of the spinel group. On the other hand these would be the very minerals to form if the alteration of olivine to iddingsite were the result of magmatic or deuteric[10] processes.

Sederholm says:

> I think that it would be advisable to discriminate between such metasomatic changes which belong to a later period of metamorphism, i. e. are secondary in the strictest sense of the word, and those which have taken place in the direct continuation of the consolidation of the magma of the rock itself. I propose to call the later deuteric, as distinct from secondary changes.

This strongly confirms the evidence presented by the restriction in occurrence and suggests that *iddingsite is a deuteric mineral*; that is, it has been produced by processes largely inherent in the magma itself, probably brought about by gases during final cooling.

The conclusion that iddingsite is a deuteric mineral first based purely on petrographic evidence is strongly supported by the chemical analyses. The ordinary agents of weathering would be extremely unlikely to produce an homogeneous crystal with definite optical properties and the chemical composition of iddingsite. On page 8 is given a typical analysis of iddingsite and the analysis of an olivine from rocks of the same region.

A comparison of these analyses shows that the proportion of silica has remained nearly constant, a little aluminum and calcium appear to have been added, the iron has all been changed from the ferrous to the ferric state and its proportion has greatly increased, water has been added in large amount, and magnesium has been largely abstracted. It is clear that in the change of olivine to iddingsite there has been a metasomatic replacement, and the only stages through which these rocks have passed where forces seemingly capable of performing such work have been active are those associated with magmatic cooling. It is, therefore, concluded that iddingsite is most probably a deuteric mineral formed in the presence of heat, water, and gases after the magma has reached a horizon near enough the surface to give oxidizing conditions. The magma must have come to rest before iddingsite formed for though it is a very brittle mineral it is never fractured, or distorted by flow.

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[9] Ransome, Frank L., Univ. of Calif. Bull. of Dept. Geol., No. 1, p. 92, 1893.

[10] Sederholm, J. J., Com. Geol. de Finlande, Bull. No. 48, pp. 141–142, 1916.

A similar result may have been produced in other ways. Thus it is quite probable that the heat and gases given off by one lava flow would have a metasomatic action on a previous flow, and iddingsite might be the result of this action. It is doubted, however, if this effect could be widespread, and it could not produce a uniform distribution of iddingsite from top to bottom of a thick flow.

A comparison of the chemical composition of iddingsite and serpentine shows how different are the processes involved in the development of the two minerals.

*Comparative analyses of iddingsite, serpentine, and olivine*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $SiO_2$ | 38.63 | 42.17 | 44.1 | 38.76 |
| $Al_2O_3$ | 1.78 | .30 | -------- | -------- |
| $Fe_2O_3$ | 32.49 | 1.57 | -------- | -------- |
| FeO | -------- | .64 | -------- | 22.55 |
| CaO | 2.79 | -------- | -------- | trace. |
| MgO | 6.64 | 41.33 | 43.0 | 38.52 |
| $H_2O$ | 17.70 | 13.72 | 12.9 | .09 |
| | 100.03 | 99.73 | 100.0 | 99.92 |

(1) Iddingsite from La Jara Creek, Conejos quadrangle, Colo.
(2) Serpentine from Fort Henry, New York,[11] analysis No. 19.
(3) Serpentine ideal composition.
(4) Olivine from Cerro Mohera near Tres Predias, N. M.

In analyzed serpentine aluminum peroxide ($Al_2O_3$) and iron peroxide ($Fe_2O_3$) reach a maximum of 6 per cent, and a variable amount of iron monoxide (FeO) replaces magnesium oxide (MgO), but no serpentine even remotely resembling iddingsite has ever been described. Serpentine is generally believed to have been the result of metasomatic changes at some depth and seldom, if ever, the result of surface weathering, and yet its chemical composition is not very different from that of the olivine from which it is derived. The changes in the ratios of the chemical components involved in the derivation of serpentine from olivine are very much less than the changes in ratio when iddingsite is derived from olivine. It is also evident that serpentine forms under conditions where reducing conditions prevail, and most of the iron remains in the ferrous condition, while iddingsite forms where oxidizing conditions produce ferric iron.

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[11] Dana, James D., Descriptive mineralogy, p. 672, 1909.

## PETROLOGY OF IDDINGSITE-BEARING ROCKS

### RACE CREEK, COLO., OCCURRENCE

The rock containing the material represented by analysis (1) is and andesite of basaltic habit of late Tertiary age collected from a peak at the headwaters of Race Creek near the south edge of the Creede quadrangle, Colorado, and about 11 miles south of South Fork on the Creede branch of the Denver & Rio Grande Western Railroad. The rock is gray and somewhat vesicular and in the hand specimen shows phenocrysts of oligoclase, quartz, and iddingsite. The modal composition of the rock is as follows:

*Mineral composition of andesite from Race Creek, Colo.*

| | |
|---|---|
| Quartz | 0.5 |
| Plagioclase (oligoclase) | 60.0 |
| Augite | 18.7 |
| Iddingsite | 8.5 |
| Olivine | 3.8 |
| Magnetite | 8.0 |
| Apatite | 0.5 |
| Total | 100.0 |

This rock contains augite and magnetite in notable proportions, but the feldspars are sodic and like the Brazos River Rock it would be classed as an andesite. The iddingsite occurs in euhedral pseudomorphs after olivine reaching 3 millimeters in length and in subhedral aggregates. The alteration from olivine to iddingsite is not complete in all grains, but the large difference in specific gravity of olivine and iddingsite allowed its elimination. Part of the material was rich in particles of magnetite, but this was separated magnetically and eliminated before analysis. The particles of magnetite are arranged in lines parallel to the crystal axes of the original olivines. In thin section the iddingsite shows very distinct open shrinkage cracks, and the iddingsite occupies from 15 to 20 per cent less volume than the olivine from which it was derived.

### LA JARA CREEK, COLO., OCCURRENCE

The iddingsite of analysis (2) was concentrated from a nearly normal olivine basalt of late Tertiary age collected near the base of a cliff on La Jara Creek, 19 miles northwest of Antonnito, Conejos quadrangle, Colorado.

The rock is medium-grained, dark gray, and very coarsely vesicular. The modal composition is as follows:

*Mineral composition of basalt from La Jara Creek Colo.*

| | |
|---|---|
| Plagioclase (oligoclase) | 60.0 |
| Augite | 28.6 |
| Olivine | 1.3 |
| Iddingsite | 3.8 |
| Magnetite | 6.6 |
| Total | 100.0 |

The iddingsite occurs in masses of a maximum diameter of 4 millimeters, whose outlines are those of olivine. The olivine is only partly altered to iddingsite, but the greater specific gravity of olivine allows an almost complete separation of the two minerals. Part of the alteration product of olivine was a lemon yellow material, which under the microscope appeared to be cryptocrystalline. This material has a lower specific gravity than crystalline iddingsite and is represented by analysis No. 3. It contains many minute, highly magnetic black inclusions arranged in lines running parallel to the crystallographic axes, which are undoubtedly magnetite.

### BERNARDS FERRY, IDAHO, OCCURRENCE

A specimen of basalt from Bernards Ferry, Silver City quadrangle, Owyhee County, Idaho, contained in Lindgren's[12] studied series of rocks yielded the iddingsite used in analysis No. 4. The rock contains abundant reddish brown iddingsite, although Lindgren does not mention olivine or iddingsite in his brief description of the basalts of the region. The rock is coarse-grained, slightly vesicular, and dark gray. The modal composition is as follows:

*Mineral composition of the basalt from Bernards Ferry, Idaho*

| | |
|---|---|
| Plagioclase Ab[illegible]An[illegible] | 46.0 |
| Augite | 43.3 |
| Olivine | 2.6 |
| Iddingsite | 5.9 |
| Magnetite | 2.2 |
| Total | 100.0 |

The iddingsite is dark reddish brown and occurs as pseudomorphs after olivine. The larger grains are completely altered to iddingsite, but some of the smaller ones show outer borders of olivine around cores of iddingsite.

As in the occurrence previously described, the Bernards Ferry rock contains a cryptocrystalline substance derived from the olivine in the same manner as the deeper red crystalline material which is represented by analysis No. 5. In some specimens this forms at the core and in others as a border around the crystalline part. It seems clear that the two types of material were not the result of different conditions during formation but are dependent upon variations in the composition of the olivine from which they were derived.

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[12] Lindgren, Waldemar, U. S. Geol. Surv. Ann. Rept. 20, pt. 3.

### SOUTH ELK CREEK, COLO., OCCURRENCE

The rock containing the iddingsite represented by analysis 6 was collected at the cliffs surrounding a cirque at the head of South Elk Creek in the southwest part of the Conejos quadrangle, Colorado. The rock is of the same age as the La Jara Creek and Gato Creek occurrences. It is a nearly black basalt with conspicuous red areas of iddingsite reaching a maximum diameter of 2 millimeters. The mineral composition of the rocks is as follows:

*Mode of basalt from South Elk Creek, Colo.*

| | |
|---|---|
| Labradorite | 52 |
| Augite | 20 |
| Iddingsite | 19 |
| Magnetite | 9 |
| Total | 100 |

### GATO CREEK, COLO., OCCURRENCE

The iddingsite represented by analysis 7 was secured from a dike occurring on Gato Creek, 2 miles above Tipton's ranch in the north central part of the Conejos quadrangle, Colorado. The rock is a fine-grained, porous gray andesite with about the following mineral composition:

*Mode of andesite from Gato Creek, Colo.*

| | |
|---|---|
| Andesine | 71 |
| Augite | 15 |
| Iddingsite | 10 |
| Magnetite | 4 |
| Total | 100 |

The iddingsite occurs in rounded grains about 0.5 millimeter in diameter and is clearly derived from olivine.

### BRAZOS RIVER, N. MEX., OCCURRENCE

Analysis No. 8 is an iddingsite in an andesite occurring one-half mile east of the Brazos River in the Rio Ariba County, N. Mex., and about 15 miles south of Osier on the Durango branch of the Denver & Rio Grande Railroad. The rock appears to be an instrusive sill of Miocene age that forms a sheer 50-foot ledge at this place. A microscopic study showed that it contained a red material derived from olivine, but with no residual olivine. It is rather coarse-grained andesite, is light gray in color, and is very fresh, showing no indications of weathering. Its modal composition is as follows:

*Mineral composition of andesite from Brazos River, N. Mex.*

| | |
|---|---|
| Plagioclase ($Ab_{60}An_{40}$) | 82.9 |
| Augite | 8.7 |
| Iddingsite | 4.6 |
| Magnetite | 3.8 |
| Total | 100.0 |

This rock contains rather sodic feldspars and is unusually low in femic minerals to be olivine bearing, but the form of the red alteration product shows that it was derived from that mineral, and other specimens from the same horizon in the region show olivine in all degrees of alteration to iddingsite. The alteration mineral occurs in irregularly rounded grains, in aggregates of several grains, and as perfectly bounded, pseudomorphs after olivine, varying in size from 0.05 to 2 millimeters. Many of the grains contain minute particles distributed in lines that run parallel to one of the crystallographic axes of the original olivine. In partly altered olivine, between iddingsite and colorless olivine, may be seen a brown zone which is filled with lines of inclusions that continue into homogeneous iddingsite. These inclusions are dark brown in color and very small. They are isotropic and have an index of refraction a little lower than 1.74. Their specific gravity is greater than that of iddingsite, since it was possible to separate and reject that part of the iddingsite containing them in greatest amount. These things make it seem probable that they are iron-magnesium spinel.

## PHYSICAL PROPERTIES

Iddingsite from many localities has been studied, but the material from Brazos River, N. Mex., is the most homogeneous and shows the physical properties in greatest perfection. For that reason the Brazos iddingsite will be described in detail and that from other localities more briefly.

The iddingsite of the Brazos River rock is very brittle. The hardness is about 3.5 and the specific gravity 2.80. In small grains the cleavage is somewhat imperfect, but four cleavages can be recognized. If the orientation X=a, Y=b, Z=c ($\mathfrak{a}=a$, $\mathfrak{b}=b$, $\mathfrak{c}=c$), proposed by Lawson, is retained, there is one cleavage (100) perpendicular to the acute bisectrix; a second (001) is perpendicular to the obtuse bisectrix; a third (010) is parallel to the plane of the optic axes; and the fourth (101) is nearly perpendicular to an optic axis. That is, a cleavage parallel to the macropinacoid, one parallel to the basal pinacoid, one parallel to the brachy-pinacoid, and one parallel to the macrodome. In thin sections three cleavages (100) (001) and

(010) can easily be recognized, and (101) is seen less frequently. The indices of refraction are:

$\alpha=1.792\pm0.003$ $\beta$ is variable, 1.827 to $1.840\pm0.003$

$\gamma=1.864\pm0.003$ $\alpha-\gamma=0.072$

The axial angle is variable, the extreme values of 2V ranging from 60 to 90°, but most of the grains have 2V=80 to 90°. The optical character is usually negative, but in some of the grains the optical angle passes through 90° and the mineral becomes positive. The dispersion is strong: $\rho<\upsilon$ when the character is negative and $\rho>\upsilon$ when it is positive. The color is deep reddish brown to brownish-ruby red, and the pleochroism is distinct in all but basal sections. The indices of refraction of the iddingsite from the Brazos River rock are rather high but the other optical properties are similar to those of other occurrences.

The iddingsite from Race Creek, Colo., is brittle. The hardness is about 3.2, and the specific gravity about 2.54. In small grains the color is dull dark brown. Three mutually perpendicular cleavages (100), (001), and (010) are very good and a less perfect one (101) gives plates that are nearly perpendicular to an optic axis. X=a is the acute bisectrix. The indices of refraction are somewhat variable $\alpha=1.608\pm.005$ $\beta=1.646\pm.005$, $\gamma=1.655\pm.005$ $\alpha-\gamma=.047$ 2V=20°—50°, but a large proportion of the grains have 2V=35°—42°, and only a few reach the maximum values given. The optical character is negative. The dispersion is strong $\rho<\upsilon$. In thin section the color is golden yellow to golden brown, pleochroism slight.

The iddingsite from Bernards Ferry, Silver City quadrangle, Idaho, is deep reddish brown in color. It has very perfect cleavage, but the great brittleness prevents a good development of the cleavage. Cleavages parallel to the planes of the three crystal axes are well developed, and the large number of plates approximately perpendicular to an optic axis indicate a fourth. Cleavages (100), (001), (010), and (101). Optical orientation X=*a*, Y=*b*, Z=*c*.

The indices of refraction are: $\alpha=1.710\pm.005$, $\beta=1.722\pm.005$, $\gamma=1.754\pm.005$, $\alpha-\gamma=.044$. The optical angle is variable 2V=20° to 65°, most of the grains about 50°. The optical character is negative, dispersion strong. The color is deep brownish red, pleochroism slight.

For purposes of comparison the optical properties of iddingsite from other localities are given below:

1. Type material from carmeloite, Carmelo Bay, Calif.; reddish brown; extinction parallel to cleavage; X is normal to cleavage plates. Optically negative. Dispersion $\rho<\nu$ (strong). Pleochroic. $\alpha=1.723\pm.003$. $\beta=1.745\pm.003$. $\gamma=1.765\pm.003$. $\alpha-\gamma=0.42$. 2V large.

2. Head of Mill Gulch, south central part of Uncompahgre quadrangle. Gabbro inclusion in basalt. Deep reddish brown grains. X is normal to cleavage plates. Extinction parallel to cleavage. 2V=40° estimated. Optically negative. Dispersion $\rho<\upsilon$(strong). Pleochroic. Indices $\alpha=1.724\pm.003$. $\beta=1.745\pm.003$. $\gamma=1.768\pm.003$. $\alpha-\gamma=.044$.

3.[13] Pyroxene latite, Wicher Mountain knoll, Pikes Peak quadrangle. Reddish brown grains. Optically—. 2V large. $\rho<\nu$ (strong). X normal to the plates. Indices vary somewhat $x=1.71\pm 0.01$. $\beta=1.74\pm0.01$. $\gamma=1.76\pm0.01$. $\alpha-\gamma=.05$.

4. Uncompahgre quadrangle, Colorado. In thin section clear pale reddish brown. Optical properties vary a little. Optically+. 2V large. $\rho>\nu$ (strong). Faintly pleochroic. $\alpha=1.70\pm0.01$. $\beta=1.72\pm 0.01$. $\gamma=1.74\pm0.01$. $\alpha-\gamma=.04$.

5. La Jara Creek, Conejos quadrangle, Colorado. Bright reddish brown. Optical properties vary a little. Optically—. 2V=25° to 45°. $\rho<\upsilon$(strong). Pleochroic. X perpendicular to plates. $\alpha= 1.674\pm0.0004$. $\beta=1.710\pm0.004$. $\gamma=1.718\pm0.004$.

*Table of optical properties of iddingsite*

| Locality | Optical angle 2V | Indices of refraction | | | $\gamma-\alpha$ | Optical character |
|---|---|---|---|---|---|---|
| | | $\alpha$ | $\beta$ | $\gamma$ | | |
| Race Creek, Colo | 35°–42° | 1.608 | 1.650 | 1.655 | 0.047 | — |
| La Jara Creek, Colo | 25°–45° | 1.674 | 1.715 | 1.718 | 0.044 | — |
| Bernard's Ferry, Idaho | 50° | 1.710 | 1.746 | 1.754 | 0.044 | — |
| South Elk Creek, Colo | [a] 60° | 1.710 | 1.735 | 1.745 | 0.35 | + |
| Gato Creek, Conejos quadrangle, Colorado | 20°–25° | 1.70 | 1.73 | 1.74 | 0.040 | — |
| Brazos River, N. Mex | 60°–90° | 1.792 | 1.827–1.846 | 1.864 | 0.072 | — |
| Mill Gulch, Colo | 40° | 1.724 | 1.763 | 1.768 | 0.044 | — |
| Uncompahgre quadrangle Colorado | Large. | 1.70 | 1.72 | 1.74 | 0.04 | + |
| Wicher Mountain, Colo | Large. | 1.71 | 1.74 | 1.76 | 0.05 | — |
| Carmelo Bay, Calif | Large. | 1.723 | 1.745 | 1.765 | 0.042 | — |
| Daton Peak, Routt County, Colo | 35°–42° | 1.720 | 1.725 | 1.760 | 0.040 | — |
| Death Valley, Calif | 42° | 1.730 | 1.725 | 1.765 | 0.035 | — |

[a] About.

## CHEMICAL COMPOSITION

Iddingsite has not heretofore been analyzed because of its mode of occurrence, always as small grains, as a rock constituent which made the obtaining of pure material, in amount sufficient for quantitative chemical examination, exceedingly difficult. In the course of the present work there were purified and analyzed, more or less completely, six samples of clean crystalline iddingsite from as many localities together with cryptocrystalline materials associated with two of the crystalline materials analyzed.

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[13] 4, 5. Larsen, Esper S., U. S. Geol. Survey Bull. 679, p. 91, 1921.

In most cases the samples of purified material available amounted to only 0.25 gram. These samples were separated by the use of a powerful electromagnet and heavy solutions from igneous rocks in which the iddingsites formed grains seldom exceeding 2 millimeters in diameter. In general the practice was to crack the iddingsite-bearing rock into small pieces with a hammer and gouge out the visible iddingsite with a sharp steel point yielding a product of high iddingsite content for subsequent treatment. This was crushed and screened to uniform size, the dust removed, and the material separated magnetically and with methylene iodide gravity solutions.

The mineral, as established by previous investigators, is insoluble in acids, but upon digestion in hot hydrochloric acid yields up its iron and probably its other bases, leaving decolorized scales. This phenomenon has been interpreted as evidence indicating that the iron is not essential to the composition but is present as staining films of limonite or hematite. The fallacy of this reasoning is patent when it is recalled that many minerals behave thus, even so common a substance as biotite leaving decolorized scales of silica retaining the original form and optical properties of the mineral, when digested in hot concentrated sulphuric acid. Few would venture to suggest, from this observation, that the iron of biotite is nonessential or extraneous.

The analytical results on the iddingsites are given in the following tables:

1. Crystalline iddingsite from Race Creek, Colo.
2. Crystalline iddingsite from La Jara Creek, Colo.
3. Cryptocrystalline material associated with the iddingsite from La Jara Creek of the preceding analysis.
4. Crystalline iddingsite from Bernards Ferry, Owyhee County, Idaho. Specimen collected by Lindgren.
5. Cryptocrystalline material associated with the preceding iddingsite from Bernards Ferry, Idaho.
6. Crystalline iddingsite from South Elk Creek, Colo.
7. Crystalline iddingsite from Gato Creek, Conejos quadrangle, Colo.
8. Crystalline iddingsite of high index from Rio Brazos, N. Mex. Original analysis.
9. Iddingsite from Rio Brazos. Preceding analysis corrected for impurities and recalculated to 100 per cent.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $SiO_2$ | 42.12 | 38.63 | 44.38 | 40.28 | 44.40 |
| $TiO_2$ | -------- | .24 | .11 | .12 | .16 |
| $Al_2O_3$ | -------- | 1.78 | 2.65 | 3.16 | 2.28 |
| $Fe_2O_3$ | 34.16 | 32.49 | 26.87 | 29.76 | 29.00 |
| FeO | None. | Trace. | -------- | -------- | -------- |
| CaO | 1.72 | 2.79 | 2.54 | 3.00 | 2.20 |
| BaO | -------- | Trace. | Trace. | -------- | -------- |
| MgO | 6.40 | 6.64 | 5.13 | 10.36 | 7.12 |
| $H_2O$+110° C | 8.84 | 9.24 | 10.09 | 5.28 | 6.96 |
| $H_2O$−110° C | 7.20 | 8.46 | 8.64 | 8.12 | 8.40 |
| Total | 100.44 | 100.27 | 100.41 | 100.08 | 100.52 |

| | (6) | (7) | (8) | (9) |
|---|---|---|---|---|
| $SiO_2$ | 35.60 | 38.94 | 23.22 | 21.02 |
| $Al_2O_3$ | 3.60 | 4.62 | 3.18 | 2.18 |
| $Fe_2O_3$ | 31.24 | 29.78 | 53.88 | 57.27 |
| FeO | -------- | .96 | .72 | .67 |
| CaO | 1.64 | 2.26 | 2.36 | 1.64 |
| MgO | 11.92 | 4.96 | 3.01 | 2.50 |
| $H_2O$+110° C | 9.80 | 9.30 | 9.36 | 9.96 |
| $H_2O$−110° C | 6.72 | 8.40 | 4.48 | 4.76 |
| Total | 100.52 | 99.22 | 100.21 | 100.00 |

Excluding from consideration, for the moment the cryptocrystalline materials, columns 3 and 5, and the Brazos River sample, columns 8 and 9, the remaining analyses are decidedly similar as shown by the following comparison and average:

| | (1) | (2) | (4) | (6) | (7) | Average |
|---|---|---|---|---|---|---|
| $SiO_2$ | 42.12 | 38.63 | 40.28 | 35.60 | 38.94 | 39.11 |
| $TiO_2$ | -------- | .24 | .12 | -------- | -------- | [a].18 |
| $Al_2O_3$ | -------- | 1.78 | 3.16 | 3.60 | 4.62 | 3.29 |
| $Fe_2O_3$ | 34.16 | 32.49 | 29.76 | 31.24 | 29.78 | 31.49 |
| FeO | None. | Trace. | -------- | -------- | .96 | [a].96 |
| CaO | 1.72 | 2.79 | 3.00 | 1.64 | 2.26 | 2.28 |
| MgO | 6.40 | 6.64 | 10.36 | 11.92 | 4.96 | 8.05 |
| $H_2O$+110° C | 8.84 | 9.24 | 5.28 | 9.80 | 9.30 | 8.49 |
| $H_2O$−110° C | 7.20 | 8.46 | 8.12 | 6.72 | 8.40 | 7.78 |
| Total | 100.44 | 100.27 | 100.08 | 100.52 | 99.22 | 101.63 |

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[a] The amounts here indicated are probably about what the averages would be were these constituents accurately determined on each sample. In most of the analyses, owing to scarcity of material $TiO_2$ is included with $SiO_2$ and the FeO—, always very small in amount, is included with $Fe_2O_3$. This explains the high summation of the average column.

The average column gives the following ratios:

| | | | | | |
|---|---|---|---|---|---|
| $SiO_2$ | 39. 11 | 0. 649 | 0. 651 | 0. 217 × 3 | 0. 96 × 3 |
| $TiO_2$ | . 18 | . 002 | | | |
| $Al_2O_3$ | 3. 29 | . 032 | . 229 | . 229 × 1 | 1. 01 × 1 |
| $Fe_2O_3$ | 31. 49 | . 197 | | | |
| FeO | . 96 | . 013 | . 254 | . 254 × 1 | 1. 11 × 1 |
| CaO | 2. 28 | . 041 | | | |
| MgO | 8. 05 | . 200 | | | |
| $H_2O+$ | 8. 49 | . 471 | . 899 | . 225 × 4 | . 99 × 4 |
| $H_2O-$ | 7. 78 | . 428 | | | |
| Total | 101. 63 | | | | |

The formula derived from the ratios is:

$$MgO \, . \, Fe_2O_3 \, . \, 3SiO_2 \, . \, 4H_2O \, .$$

with the magnesia replaced in part by CaO which is in the ratio, approximately, of CaO : MgO = 1 : 4. The calculated composition for this formula is as follows:

| | |
|---|---|
| $SiO_2$ | 39. 66 |
| $Fe_2O_3$ | 35. 01 |
| CaO | 2. 46 |
| MgO | 7. 07 |
| $H_2O+$ | 7. 90 |
| $H_2O-$ | 7. 90 |
| Total | 100. 00 |

In view of the agreement of the above analyses with each other and with the theoretical composition, this formula may be confidently quoted as that of the normal iddingsite. This is especially true since a comparison of optical properties indicates that the above are typical of 95 per cent of all iddingsites studied by the writers or reported by others. Nearly all of the red-brown material secondary to olivine is shown by its refractive indices and other properties to be of this type and presumably of this composition.

The cryptocrystalline materials represented by analyses 3 and 5 give the same formula as the crystalline iddingsites. They are distinguished by pale yellow color, low refractive indices, and very small extinction angle. Often there is a sharp contact between the iddingsite and the cryptocrystalline material while the latter grades almost imperceptibly into the residual olivine. This cryptocrystalline material may represent a transition stage in the alteration of olivine to iddingsite. While of the same composition, it is sufficiently distinct optically to suggest that it is a distinct mineral—possibly a variety of chloropal. It is certainly not the material commonly called iddingsite.

One disturbing factor is introduced into otherwise consistent data by the Brazos River material represented by the anlaysis given in columns 8 and 9 of the above tabulation. This analysis, which differs strikingly from all the others, gives the formula $(Mg.Ca)O.5Fe_2O_3.4SiO_2.10H_2O$. This sample was the first one studied and about 1 gram of material which was separated for analysis was estimated to contain 2 per cent of augite and 4 per cent of plagioclase of the composition $Ab_{60}An_{40}$. The figures given in colunm 9 have been recalculated after correcting for these impurities. The loss of water below 110° C. was determined on two portions yielding 4.40 and 4.48 per cent, respectively, with one hours heating while several hours continued exposure to this temperature occasioned no further loss. The dehydrated powder showed no change in any of its optical properties. A gain of 2.28 per cent of the original weight was acquired by a dried sample upon standing overnight in a dessicator over sulphuric acid.

While this material is chemically very unlike the others the optical properties, other than refractive index, are those typical of iddingsite. The refractive indices are very high as would be expected from the high content of ferric iron, and no other occurrences of such high refractive index have been recorded. Optically it seems to be a true iddingsite but until similar materials from other localities have been analyzed no conclusions can be drawn with regard to its relationship to the ordinary iddingsites of the above group.

## SUMMARY

Iddingsite is a red-brown mineral that is widespread, and often an abundant mineral in basaltic rocks.

It occurs as cores in fresh olivine, as rims around olivine, or where cleavage cracks in olivine have formed a locus for its development. Therefore it is clearly a secondary mineral derived from olivine.

Iddingsite is not confined to weathered surfaces; its development shows no proximity to joint cracks and evidences of weathering in associated minerals are entirely absent. Normal products of weathering such as limonitic pigment are absent, but spinels (minerals not produced by weathering) are abundant and almost invariable associates. Thus it is concluded that iddingsite is not a product of ordinary weathering but is a deuteric mineral; that is, it is the result of metasomatic processes associated with the later stages of a cooling magma.

Iddingsite does not commonly occur in abyssal rocks, but is confined to extrusive and hypabyssal rocks. The relations indicate that it is formed near or just after the close of crystallization, and after the magma came to rest. The factors necessary for the formation are an olivine of suitable composition, a concentration of mineralizers (principally water), oxidizing conditions and heat.

The changes involved are principally abstraction of magnesium oxide (MgO), oxidization of ferrous oxide (FeO) to ferric oxide ($Fe_2O_3$) and addition of water ($H_2O$).

Iddingsite has a composition and optical properties distinct from any described mineral, and it is not related to serpentine in mode of origin, in chemical composition, or in physical properties. Thus it appears to be a distinct mineral species.

The normal type of iddingsite is represented by the formula: $MgO . Fe_2O_3 . 3SiO_2 . 4H_2O$ where MgO is replaced by CaO in the ratio 4:1, and varying proportions of $Fe_2O_3$ are replaced by $Al_2O_3$.

## EXPLANATION OF PLATES

### PLATE 1

FIG. 1. Iddingsite from andesite collected at the headwaters of Race Creek near the south border of Creede quadrangle, Colorado. Open cracks show the loss of volume on alteration of olivine to iddingsite. Alteration is complete.

2. Iddingsite in andesite from 1 mile west of Osier, N. Mex., near Colorado-New Mexico State line. Shows characteristic outline of olivine crystals. Alteration nearly complete.

3. Iddingsite in basalt from Santa Clara Creek, 13 miles west of Espanola, N. Mex. Iddingsite forming sharp outer borders around unaltered olivine.

4. Andesite from southeast flank of Green Mountain, northern part of Conejos quadrangle, Colorado. Euhedral phenocrysts of olivine with very narrow outer border of iddingsite.

5 and 6. Basalt from cliff on north side of Los Magotes, southeast part Conejos quadrangle, Colorado. Iddingsite core with narrow sharp outer border of olivine.

### PLATE 2

FIG. 7. Basalt with iddingsite collected 4 miles south of the crest of San Antonio Peak and 8 miles north of Tres Piedras, N. Mex. Large phenocrysts of olivine with core of iddingsite and outer rim of olivine.

8. Basalt from cliffs on north side of Los Magotes, Conejos quadrangle, Colorado. Many small grains of iddingsite with sharp outer rim of olivine. Large crystal on upper border shows core of olivine.

9. Basalt from mouth of Rito de los Frijoles Canyon, 10 miles southwest of San Ildefonso, N. Mex. Phenocryst of olivine showing alteration to iddingsite along border and cracks.

10. Basalt dike in Cerro Negro volcanic cone about 10 miles east of Tres Piedras, N. Mex. Phenocryst of olivine with very narrow sharp films of iddingsite developing along cracks.

11. Iddingsite in Brazos River andesite from one-half mile east of Brazos River, N. Mex., about 15 miles south of Osier, Colo. Iddingsite crystal showing characteristic outline of olivine. Near the center of crystal are shown 2 cleavages parallel to crystal axes and the cleavage parallel to the macrodome (101).

12. Basalt from west slope of Mesa La Sauses, 10 miles east of La Jara, Colo. Phenocryst of olivine entirely altered to iddingsite.

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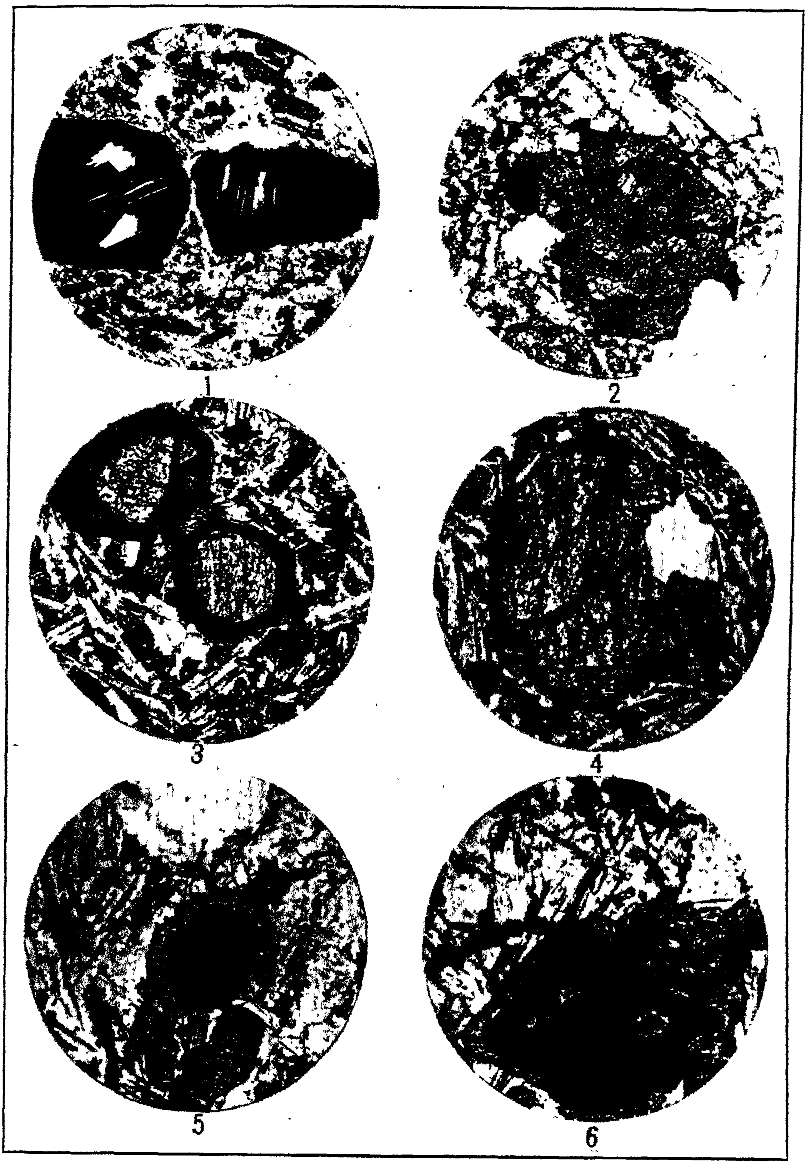
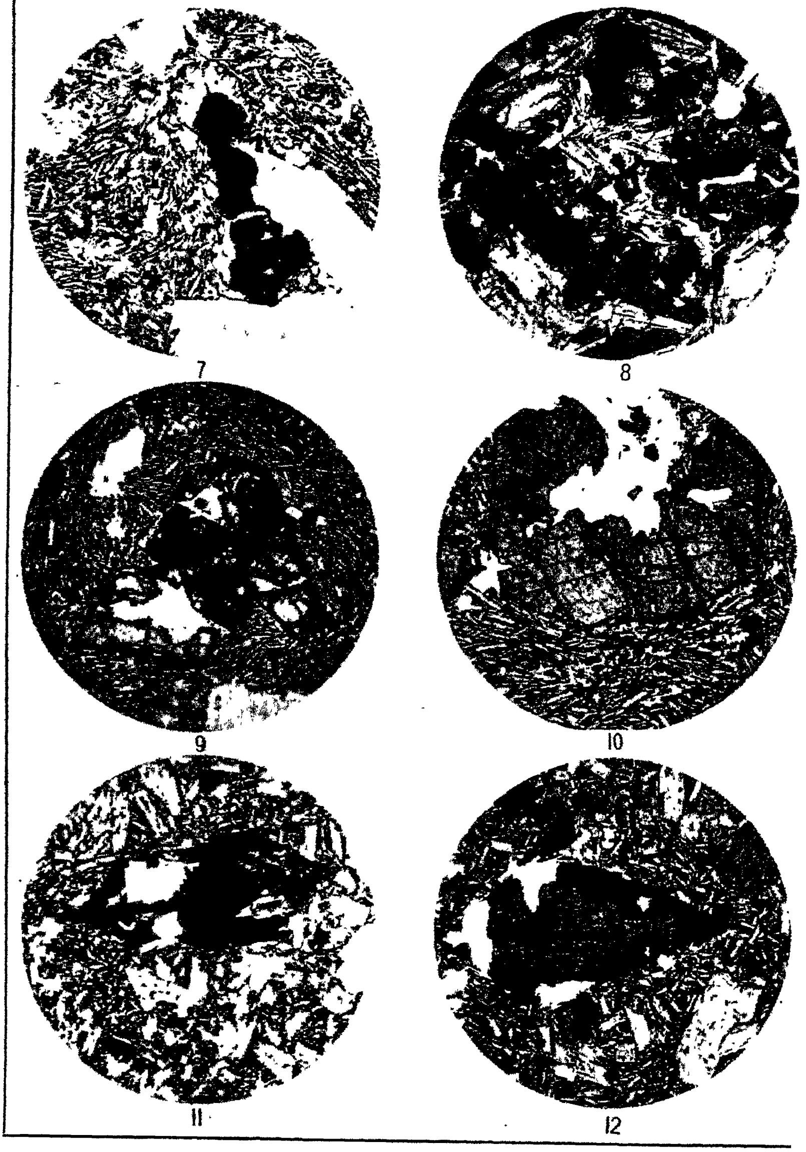


PHOTOMICROGRAPHS OF IDDINGSITE-BEARING ROCKS

FOR EXPLANATION OF PLATE SEE PAGE 19



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PHOTOMICROGRAPHS OF IDDINGSITE-BEARING ROCKS

FOR EXPLANATION OF PLATE SEE PAGE 19

# A REVISION OF THE PARASITIC WASPS OF THE GENUS MICROBRACON OCCURRING IN AMERICA NORTH OF MEXICO

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## INTRODUCTION

Ashmead[1] published the name *Microbracon* with the following description: "I propose this new genus for the reception of those species in the genus *Bracon* having the recurrent vein joining the first submarginal cell between its middle and its apex, restricting the genus *Bracon* to those species having the recurrent vein interstitial with the first transverse cubital. The majority of species belonging to this new genus known to me are all small and resemble certain yssalids." Subsequently Ashmead[2] greatly restricted the genus *Bracon*, separating it from *Microbracon* by a group of characters which are certainly not of generic or even of subgeneric value. Since that date Viereck[3] has shown that the name *Bracon* Fabricius must be used for *Cremnops* Foerster, a genus in the Agathidinae, and[4] that *Microbracon* Ashmead becomes the valid name for *Bracon* of Authors not Fabricius.

The subfamily formerly known as the Braconinae, for which Gahan[5] proposed the name Vipiinae upon the transfer of *Bracon* Fabricius to another subfamily, has been largely neglected from the standpoint of generic revision and is at present very unsatisfactorily classified. Many of the genera are poorly defined, and doubtless a considerable number must eventually be placed in synonymy. It is not, however, the purpose of this paper to present a revision of the subfamily Vipiinae, and accordingly the merits of the various generic names, apart from those which are here regarded as synonyms of *Microbracon*, will not be discussed. Merely to show the relation of *Microbracon* to the remainder of the subfamily an attempt will be made to point out the more important characters distinguishing this genus from other genera or groups of genera in our fauna.

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[1] Bull. No. 1, Colo. Biol. Assoc., 1900, p. 15.

[2] Proc. U. S. Nat. Mus., vol. 23, 1900, p. 138.

[3] Bull. 83, U. S. Nat. Mus., 1914, pp. 28 and 37.

[4] Idem, p. 94.

[5] Proc. U. S. Nat. Mus., vol. 53, 1917, p. 196.

A study of the genus *Microbracon*, with the purpose of revising the group, has been induced by the abundant rearing of species of this genus in the United States Bureau of Entomology in the course of work upon various insect pests, and by the difficulty of satisfactorily identifying these species. In the prosecution of this study the chief repositories of the types, which are the United States National Museum, the Philadelphia Academy of Sciences, the Connecticut Agricultural Experiment Station, and the Museum of Public Instruction in Quebec, have been visited and the types examined. Only the types of the following have not been seen: Those of Say's four species, which are no longer in existence, so far as known; *kansensis* Viereck and *piceiceps* Viereck, which are in the collection of the University of Kansas; *diversicolor* Viereck which is on deposit at the California Academy of Sciences; and *rufomarginatus* Ashmead which could not be located.

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## CLASSIFICATION

## Superfamily ICHNEUMONOIDEA

### Family BRACONIDAE

### Subfamily VIPIINAE

*Braconoidae* FOERSTER, Verh. d. naturh. Ver. pr. Rheinl., vol. 19, 1862, pp. 227 and 234.

*Braconides* MARSHALL, Trans. Ent. Soc. Lond., 1885, p. 1.

*Braconinae* CRESSON, Syn. Hym. North America, 1887, pp. 54 and 56.

*Braconidae* Tribe I MARSHALL, in Andre, Hymen. Eur. et Alg., vol. 4, 1888, p. 68.

*Braconinae* ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 136.—SZEPLIGETI, Genera Insectorum, fasc. 22, 1904, p. 10.

*Vipiinae* GAHAN, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 196.

Head varying from transverse to cubical; mandibles normal, touching or crossing at tips and forming with the emarginate and anteriorly somewhat elevated clypeus, a more or less circular opening; occiput entirely immargined; anterior wing[6] with three cubital cells; first discoidal cell always separated from the first cubital; subdiscoideus never interstitial with the first abscissa of discoideus; second abscissa of discoideus always much longer than third; submediellan cell very short, never more than one-fourth the mediellan cell; cubitella originating at the end of mediella; postnervellus absent.

### Genus MICROBRACON Ashmead

*Bracon* NEES (part), Hymen. Icheum. affin. Monogr., vol. 1, 1834, p. 46.—FOERSTER, Verh. naturh. Ver. pr. Rheinl., vol. 19, 1862, p. 235.—MARSHALL, Trans. Ent. Soc. London, 1885, p. 11.—CRESSON, Synopsis Hymen. N. Am., 1887, p. 56.

*Microbracon* ASHMEAD, Bull. Colorado Biol. Assoc. 1, 1890, p. 15.
*Genotype.*—*Microbracon sulcifrons* Ashmead (Monobasic).

*Habrobracon* (Ashmead) JOHNSON, Ent. News, vol. 6, 1895, p. 324.
*Genotype.*—*Bracon gelechiae* Ashmead (By designation of Viereck, Bull. 83, U. S. Nat. Mus., 1914, p. 65).

*Macrodyctium* ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 138.
*Genotype.*—*Bracon cuurae* Ashmead (Monabasic).

*Bracon* ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 139.

*Habrobracon* ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 139.

*Tropidobracon* ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 139. *Genotype.*—*Bracon gastroideae* Ashmead (Monobasic).

*Liobracon* (Ashmead) NASON, not Szepligeti, Ent. News, vol. 16, 1905, p. 298.
*Genotype.*—*Bracon nuperus* Cresson (Monobasic).

*Bracon* SZEPLIGETI, Genera Insectorum, fasc. 22, 1904, p. 27.

*Amyosoma* VIERECK, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 640.
*Genotype.*—*Amyosoma chilonis* Viereck (Monobasic).

*Habrobracon* CUSHMAN, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 99.

*Habrobracon* VIERECK, Bull. 22, Conn. State Geol. and Nat. Hist. Survey, 1917 (1916), pp. 182 and 209.

*Microbracon* VIERECK, Bull. 22, Conn. State Geol. and Nat. Hist. Survey, 1917 (1916), pp. 182 and 204.

Head transverse to subquadrate, never rostriform, always wider than long antero-posteriorly; malar space variable but always much less than half the eye height; eyes oval, rather broad, bare or indis- inctly very sparsely hairy; frons not or scarcely impressed; scape hort, not or hardly longer than first flagellar segment, broadening venly from base to apex, not excavated, and not prominently med at apex; first segment of flagellum always much longer than dicel, as long as or longer than the second, and never excavated [illegible]ow nor with a prominent rim at apex; antennal segments varying in number from thirteen to forty or more; parapsidal grooves usually well indicated, with the mesonotal lobes distinct; sometimes

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[6] The wing venation terminology employed in this paper is that proposed by Rohwer and Gahan, Proc. Ent. Soc. Wash., vol. 18, 1916, pp. 20–76.

the parapsidal grooves defined only by lines of pubescence, the mesoscutum being rather flat; mesonotum, pleura and propodeum usually smooth and polished, although sometimes very finely sculptured; suture between mesoscutum and scutellum finely foveolate; propodeum rarely with a median longitudinal carina, but frequently with a stub of a median ridge at apex; wings varying from clear hyaline to strongly infumated; usually dusky on the basal two-thirds; nervulus interstitial with basal vein; recurrent vein entering first cubital cell; second cubital cell varying greatly in length, the second abscissa of radius being sometimes no longer than the first abscissa, sometimes much more than twice as long; radius usually attaining wing margin near the apex of wing, rarely much before; spurs of posterior tibiae rather short, never distinctly half the metatarsus; abdomen elliptical or ovate, conspicuously angled at the junction of first and second segments; the first abdominal tergite with lateral membranous margins, the chitinized plate of this tergite with two oblique grooves converging anteriorly; second abdominal tergite without lateral oblique diverging impressions; suturiform articulation frequently broad and foveolate; none of the following sutures deep or foveolate; third tergite without transverse or oblique impressions setting off the anterior lateral corners of the tergite; abdomen varying from entirely smooth and polished to entirely rugulose or granular; ovipositor sheaths varying from less than one-fourth the length of the abdomen to longer than the entire body. This genus includes the smallest of the Vipiinae; very rarely does the body attain a length of 5 mm.

*Microbracon* is probably more closely related to *Iphiaulax* Foerster and its allies than to any other group of the Vipiinae, although its species are much smaller than most species of *Iphiaulax* and differ considerably in general appearance. The species of *Microbracon*, however, always lack the deep and often foveolate abdominal sutures usually found in *Iphiaulax* and lack also the oblique lateral furrows on the second tergite, and the anterior corners of the third tergite are never set off by transverse impressions. *Coeloides* of Authors, which includes Viereck's *Habrobraconidea*, differs from *Microbracon* especially in the more cubical head, the excavated frons, and the short first and second flagellar segments of the antennae which are scarcely longer than the pedicel, somewhat hollowed out beneath and flaring a little at the apex. The group typified by *Atanycolus* Foerster is readily distinguished by the cubical head and impressed frons, and the scape, which is large, cylindrical, conspicuously excavated at base and apex, with prominent basal and apical margins, and supported by a cylindrical stalk. From *Compsobracon* Ashmead *Microbracon* is at once distinguished by the propodeal spiracles which are small and round while in the former they are large and linear; the unusually long scape further distinguishes *Compsobracon.* *Zavipio* Viereck is readily separated by its rostriform head, with the accompanying very long malar space, and by the usually very short radial cell.

*Habrobracon* (Ashmead) Johnson, *Macrodyctium* Ashmead, *Tropidobracon* Ashmead, *Liobracon* (Ashmead) Nason, not Szepligeti, and *Amyosoma* Viereck can not be held distinct from *Microbracon.* These groups intergrade completely, so that it is entirely impossible to determine where one ends and another begins. The characters upon which they have been separated are by no means sufficiently distinct or constant to serve to distinguish genera. The genotypes of all must, I believe, be regarded as congeneric even by those disposed toward a large increase in the number of genera, if a thorough study is made of the group.

In few groups of the Braconidae is there found so wide a range of variation within species as in *Microbracon.* Practically all characters, many of them excellent characters in other groups, vary greatly in this genus. Because of this it is always extremely desirable to have before one a good series of specimens when attempting identifications. The males are particularly difficult, exhibiting still wider variations than the females, and single specimens of this sex can sometimes be only doubtfully named. Host records are often of much value, for although few, if any, of the species are restricted to single hosts, and frequently the same species attacks both lepidopterous and coleopterous larvae, still one species usually parasitizes hosts of the same general habit or found in the same food plants. In a consideration of specific characters in *Microbracon* one is impressed by the lack of constancy in color or even color pattern, although sometimes there is a degree of uniformity which is of a little help and permits the employment of color characters to a small extent in a table to species. The color of the face and legs—whether face and coxae are yellowish or black—will be found of considerable help, although varying to a slight degree. The wings are usually somewhat fuscous, rarely clear hyaline, but the degree of infuscation varies more or less within the species, and alone is not dependable for the separation of species. In sculpture there is likewise so much variation that it becomes difficult to use sculptural characters in a key without qualification, although the presence or absence of punctate or reticulate sculpture on the frons, and on the mesonotum, pleura and propodeum is very reliable. The abdominal sculpture is variable but can be relied upon to a large degree for distinguishing between groups of species, when supported by other characters. Usually the mesonotal pubescence is restricted to the parapsidal grooves and the space behind the middle lobe, but in a few species pubescence arises over the entire surface of the lobes as well as from the parapsidal furrows; this character appears to be very constant within species. The length of the head antero-posteriorly is relatively constant, and in the small number of cases where the difference between species is sufficient to permit the employment of this character, it is good. The length of the malar space, the number and the relative length of the antennal segments have considerable value, but again, must be used with care and supported by other characters. Wing venation, particularly the length of the second abscissa of radius as compared with the first and third abscissae and with the first intercubitus, the relative length also of that part of cubitus which lies between the recurrent and the first intercubitus, and the length of the radial cell, which is dependent on the point where radius attains the wing margin, will be found very helpful, but within limits. It will be seen from this brief discussion that variability is so pronounced in species of *Microbracon* that determinations should be made only after a very careful weighing of all points. It is hoped that the following key together with the notes found in the text will aid considerably in making such determinations. Unfortunately it was found necessary to classify the females and males separately beyond the thirteenth couplet. By doing this it has been possible to present a key to the females which will probably be found quite satisfactory; while if the males had been incorporated the fullest use could not have been made of the variations in the length of the ovipositor sheaths between different species, one of the most valuable characters. Any key to the males of *Microbracon* must, it seems to me, be rather unsatisfactory, because of the apparently complete intergradation of species. The one here given will, however, probably serve to identify the normal males. The identity of those which represent the extremes in variation must often be left in doubt unless they can be connected by biological records with females or more normal males. In the following table 66 species are included in the female key and 73 species in the male key; seven species which are known only in the male sex, and in all cases but one based upon a single specimen, can not be placed in the female key because of the necessity of making much use of the relative length of the ovipositor sheaths in this part of the table. Some other species are known only from female specimens, and in these cases the position assigned in the male key was determined by characters exhibited by the females, after making necessary allowance for sexual variations. It has seemed desirable to place several of the species in two different positions in the female key.

### KEY TO THE SPECIES OF MICROBRACON

1. Mesoscutum and scutellum more or less, the lateral face of pronotum, the meso- and meta-pleura, propodeum and posterior coxae minutely closely punctate or reticulate, opaque — 2.

Mesoscutum, scutellum, lateral face of pronotum mostly, and mesopleura smooth and polished — 10.

2. Second abscissa of radius about twice as long as the first, decidedly longer than first intercubitus and usually distinctly more than half the third abscissa of radius; pubescence on mesoscutum restricted to the region of the parapsidal furrows; ovipositor sheaths sometimes nearly as long as the abdomen — 3.

Second abscissa of radius much less than twice as long as, often scarcely longer than, the first, not or scarcely longer than first intercubitus, and much less than half the third abscissa of radius; pubescence on mesoscutum usually not restricted to the parapsidal furrows, but arising over the surface of the lobes as well; ovipositor sheaths at most but little more than half as long as the abdomen — 5.

3. Parapsidal furrows rather thickly hairy, anteriorly as well as posteriorly; propodeum without a distinct median longitudinal groove; the portion of cubitus between first intercubitus and recurrent about half as long as first intercubitus; ovipositor sheaths less than half as long as the abdomen — 1. **quinnipiacorum** Viereck.

Parapsidal grooves sparsely hairy, especially anteriorly; propodeum with a median longitudinal groove; the portion of cubitus between first intercubitus and recurrent very short, the recurrent being nearly interstitial with first intercubitus; ovipositor sheaths as long as the abdomen beyond first tergite — 4.

4. Mesoscutum uniformly closely punctate and opaque; frons with a distinct median longitudinal groove descending from median ocellus; antennae slender, the flagellar segments much longer than broad; last abscissa of cubitus not distinctly longer than the preceding abscissa; third abscissa of radius not distinctly longer than the first and second combined — 2. **punctatus**, new species.

Mesoscutum shining, smooth and polished anteriorly; frons without a distinct groove below median ocellus; flagellar segments of female antennae rather stout, mostly but very little longer than broad; last abscissa of cubitus much longer than the preceding abscissa; third abscissa of radius distinctly longer than the first and second combined — 3. **sphenophori**, new species.

5. Second abdominal tergite rugulose or ruguloso-punctate, usually longitudinally so; if not distinctly rugulose then with a basal median embossed area set off by short longitudinal grooves; suturiform articulation usually rather broad and foveolate; oblique furrows on first tergite often broad and distinctly foveolate — 8.

Second abdominal tergite evenly closely punctate, or finely granular, not rugulose, and without a basal median area set off by longitudinal impressions; suturiform articulation usually very fine; oblique furrows on first tergite usually narrow, not foveolate — 6.

6. Ovipositor sheaths at least half as long as the abdomen; cubitus between recurrent and first intercubitus at least as long as recurrent, usually decidedly longer; propodeum without a median longitudinal carina on posterior half---------- 4. **gelechiae** (Ashmead).
5. **diversicolor** (Viereck).

Ovipositor sheaths less than half as long as the abdomen; cubitus between recurrent and first intercubitus not longer than recurrent, often shorter; propodeum with a median longitudinal carina on posterior half---------- 7.

7. Scutellum broad, at least as broad as long, very faintly sculptured, subpolished; first abscissa of radius at least as long as second, usually a little longer; radial cell very short, not longer than third cubital cell; metacarpus not longer, usually shorter, than third abscissa of radius; cubitus between recurrent and first intercubitus nearly or quite as long as recurrent; last abscissa of cubitus much more than twice the preceding abscissa---------- 6. **erucarum** (Cushman).

Scutellum a little longer than broad at base, minutely reticulately sculptured and opaque; first abscissa of radius not as long as the second; metacarpus longer than third abscissa of radius; cubitus between recurrent and first intercubitus much shorter than recurrent; last abscissa of cubitus not more than twice the preceding abscissa.
7. **americanus** (Ashmead).

8. Antennae rather stout, distinctly tapering somewhat toward the tip, in the female 19 to 22-segmented, the flagellar segments but very little longer than broad; head and thorax usually mostly yellowish; the black ocellar spot usually nearly separated from the occipital spot; face mostly or wholly pale---------- 8. **cushmani**, new name.

Antennae slender, not distinctly tapering toward the tip; flagellar segments in the female much longer than broad; head and thorax usually mostly black; ocellar and occipital spots broadly confluent; face largely blackish---------- 9.

9. Ovipositor sheaths fully half as long as the abdomen; second abdominal tergite and the third basally not longitudinally rugulose; the oblique furrows on first tergite not distinctly foveolate; the portion of cubitus between recurrent and first intercubitus longer than recurrent; first abscissa of radius very nearly or quite as long as the second.
9. **platynotae** (Cushman).

Ovipositor sheaths less than half as long as the abdomen; second abdominal tergite and the third basally longitudinally rugulose; the oblique furrows on first tergite broad and foveolate; the portion of cubitus between recurrent and first intercubitus not longer, usually shorter, than recurrent; first abscissa of radius nearly always shorter than second.
10. **xanthonotus** (Ashmead).

10. Second abscissa of radius not or scarcely longer than the first abscissa, not longer than first intercubitus and hardly one-third as long as third abscissa of radius; mesonotal lobes pubescent; antennae stout, tapering to the tip, the female antennae 13 to 19-segmented and not extending beyond the apex of the thorax; ovipositor sheaths hardly half as long as the abdomen---------- 11.

Second abscissa of radius much longer than the first abscissa, longer than first intercubitus, and very rarely less than half as long as third abscissa of radius; mesonotal lobes usually bare, the pubescense nearly always restricted to the region of the parapsidal furrows; female antennae not as above---------- 12.

11. Antennae of female 13 to 15-segmented; of male, 18 to 23-segmented; first flagellar segment of male antennae usually distinctly longer than the second, the segments beyond the first but very little longer than broad; abdomen smooth and shining, rarely distinctly punctate. 11. **hebetor** (Say).

Antennae of female 17 to 19-segmented, very rarely 16-segmented; of male, 20 to 27-segmented, the first flagellar segment of male antennae usually not distinctly longer than the second, the segments beyond the first one and one-half times as long as broad; 3d, 4th, and 5th abdominal tergites nearly always distinctly punctate ---------- 12. **brevicornis** (Wesmael).

12. Stigma long and narrow, the radius arising distinctly behind its middle; radial cell short, ending far before apex of wing; first abscissa of radius very short, much less than half the first intercubitus; abdomen sculptured above ---------- 13.

Radius arising at or before middle of stigma ---------- 14.

13. Propodeum mostly smooth and shining, without a complete median longitudinal carina; ovipositor sheaths about as long as the abdomen 13. **scanticorum** Viereck.

Propodeum finely rugulose except at extreme base and provided with a prominent median longitudinal carina; ovipositor sheaths about as long as the abdomen beyond 2d tergite ---------- 14. **pyralidiphagus**, new species.

14. Females ---------- 15.

Males ---------- 69.

15. Dorsum of abdomen mostly smooth and polished, the sculpture when present restricted to the three basal tergites, only rarely occurring on the third; the sculpture on second and third tergites when present usually in the form of longitudinal striae and usually restricted to the middle two-thirds of the tergite; propodeum mostly or entirely smooth and polished; frons usually smooth and polished, if sculptured, the face and coxae are black; face rarely yellow; if so, the abdomen, including first and second tergites, is entirely smooth and polished ---------- 16.

Dorsum of abdomen sculptured, although sometimes very minutely so, over most of its surface; very rarely not distinctly sculptured beyond second tergite, but then the latter is entirely finely granular, the frons is finely reticulately sculptured and the face and coxae are yellow; face and coxae very rarely black; if so, then abdomen is distinctly sculptured over nearly its entire surface ---------- 39.

16. Ovipositor sheaths protruding at least very nearly the length of the abdomen, sometimes much longer ---------- 28.

Ovipositor sheaths protruding not more than half the length of the abdomen beyond its apex ---------- 17.

17. Opening between clypeus and mandibles unusually large, its transverse diameter at least as long as the distance from lower margin of antennal foramina to lower margin of clypeus; posterior tarsi short and stout, much shorter than posterior tibiae; propodeum with a nearly complete median longitudinal carina; at least posterior coxae black; ovipositor sheaths protruding less than the length of the first abdominal tergite ---------- 18.

Opening between clypeus and mandibles not so large; posterior tarsi usually at least as long as their tibiae; propodeum very rarely with a nearly complete median carina, and then not combining all the above characters ---------- 19.

18. Wings strongly infumated; last segment of posterior tarsi unusually large, broadening strongly from base to apex, much longer than the second segment and nearly as long as the metatarsus; antennae usually 24 to 30-segmented; propodeum mostly smooth except for the median carina 15. **gastroideae** (Ashmead).

Wings hyaline or very nearly; last segment of posterior tarsi not so large; antennae usually 21 to 24-segmented; propodeum finely rugulose 16. **brachyurus** (Ashmead).

19. Second abdominal tergite with conspicuous, more or less triangular, areas of weaker chitinization laterally joining the broad membranous margins of the first tergite; second tergite much shorter than the third; dorsum of abdomen entirely smooth and polished, without even a suggestion of sculpture; longitudinal groove on lateral face of pronotum incomplete, being distinct only anteriorly ---------- 20.

Second abdominal tergite not as above; at least not agreeing entirely with the above characterization ---------- 21.

20. Head and thorax black; abdomen mostly black; legs more or less blackish ---------- 17. **melanaspis** (Ashmead).

Body mostly yellowish or yellowish-brown, legs, including coxae, yellowish ---------- 18. **juncicola** (Ashmead.)

21. Frons entirely, and usually the vertex to some extent, closely minutely punctate or reticulate and opaque; parapsidal grooves entirely thickly hairy; head black with contrasting yellow orbital lines; thorax short and stout, black; wings rather strongly dusky on basal half; second abscissa of radius rarely distinctly twice the first ---------- 22.

Frons smooth and polished, at most with faint sculpture just above insertion of antennae; at least not combining all the above characters ---------- 23.

22. Second abdominal tergite usually smooth and shining, and provided with two abbreviated oblique foveolate impressions medially toward base; scattered pubescence arising from surface of middle lobe of mesoscutum anteriorly; antennae normally 21 to 25-segmented ---------- 19. **politiventris** (Cushman).

Second abdominal tergite finely sculptured over nearly its entire surface and without such impressions on the basal middle; surface of middle lobe of mesoscutum without pubescence although the long hairs arising from the parapsidal furrows lie upon the lobes; antennae normally 24 to 29-segmented ---------- 20. **pygmaeus** (Provancher).

23. Head thin antero-posteriorly, hardly thicker at insertion of antennae than at clypeus, the face not distinctly receding; propodeum completely polished, without a stub of a median ridge at apex; first abdominal tergite wholly smooth and polished; head and thorax black; coxae black. 21. **connecticutorum** Viereck.

Head not so thin, rather prominent just below insertion of antennae, the face receding; propodeum usually with a distinct stub of a median ridge posteriorly ---------- 24.

24. Abdomen wholly smooth and polished, the second tergite with two abbreviated oblique furrows medially setting off a basal median area; parapsidal furrows thickly hairy; head more than usually thick antero-posteriorly, being about as thick antero-posteriorly just below insertion of antennae as high; antennae normally 30 to 32-segmented, tapering distinctly toward tip; face yellow; thorax usually mostly yellow ---------- 22. **psilocorsi** Viereck.

Second abdominal tergite without oblique furrows setting off a basal median area; parapsidal grooves sparsely hairy; head, including face, and thorax black ---------- 25.

25. Second and third abdominal tergites almost entirely minutely granular; propodeum usually with a nearly complete median longitudinal carina.
23. **meromyzae** (Gahan).

Third and following abdominal tergites completely smooth and polished; second tergite only with faint roughening medially ---------- 26.

26. Hypopygium attaining apex of abdomen; ovipositor sheaths slender; legs, including all coxae, and the abdomen laterally and on the venter, bright yellow; propodeum smooth and polished with only a very short stub of a median ridge posteriorly; posterior tarsi slender.
24. **nigridorsum** (Ashmead).

Hypopygium not distinctly attaining apex of last dorsal abdominal segment; ovipositor sheaths broad; abdomen usually black; posterior tarsi rather stout, the last tarsal segment as long as the second and more than half the metatarsus ---------- 27.

27. All coxae and more or less of the femora black -- 25. **ashmeadi**, new name.

Legs yellow, the posterior coxae blackish at base ------ 26. **uncas** Viereck.

28. Antennae very slender, all the flagellar segments more than twice as long as thick; legs including all coxae bright yellow; wings perfectly clear hyaline, with no suggestion of duskiness ---------- 29.

Antennae not so slender; at least not combining the above characters -- 30.

29. Ovipositor sheaths nearly as long as the body; abdomen entirely smooth and polished; face yellow; thorax and abdomen largely yellowish.
27. **angelesius** (Provancher).

Ovipositor sheaths slightly shorter than the abdomen; second abdominal tergite finely striate; head, including face, black; thorax and abdomen largely black ---------- 28. **auripes** (Provancher).

30. Head thin antero-posteriorly, the face rather flat, not prominent at insertion of antennae and scarcely receding below; propodeum completely smooth and polished, without a stub of a median ridge at apex; ovipositor sheaths at least a little longer than the abdomen, and usually fully as long as the body; antennae normally 20 to 30-segmented ---------- 31.

Head rather thick antero-posteriorly at insertion of antennae, the face distinctly receding below; propodeum usually with a stub of a median ridge at apex; ovipositor sheaths at most a little longer than the abdomen -- 34.

31. Second abdominal tergite with conspicuous membranous or weakly chitinized areas laterally opposite the broad membranous margins of the first tergite; ovipositor sheaths as long as the body, antennae usually 20 to 26-segmented ---------- 32.

Second abdominal tergite without such membranous areas laterally; head and thorax usually black or blackish; coxae usually, though not always, black or brown ---------- 33.

32. Head, thorax, abdomen, legs, mostly yellow; second abdominal tergite usually as long as the third or nearly ------ 29. **rudbeckiae**, new species.

Head and thorax wholly black; abdomen black except for the membranous parts of first and second tergites; second tergite much shorter than third ---------- 30. **tenuiceps**, new species.

33. Ovipositor sheaths as long as the body; second abdominal tergite more or less sculptured ---------- 31. **nuperus** (Cresson).

Ovipositor sheaths slightly longer than the abdomen; abdomen completely smooth and polished ---------- 32. **curtus** (Provancher).

34. Transverse diameter of opening between clypeus and mandibles but little or no greater than the distance from the opening to the eyes; malar space about as long as first segment of antennal flagellum---------- 35

Transverse diameter of opening between clypeus and mandibles much greater than the distance to the eyes; malar space shorter than first segment of antennal flagellum-------------------------------------- 37.

35. Thorax stout, not nearly twice as long as high; stigma brown, with its costal thickening and more or less of the membrane toward base, bright yellow; antennae normally 30 to 34 segmented; ovipositor sheaths a little longer than the abdomen-------------------- 33. **hyslopi** Viereck.

Thorax not stout, very nearly twice as long as its greatest height; stigma unicolorus, brown; antennae normally 25 to 30-segmented; ovipositor sheaths scarcely as long as the abdomen------------------ 36.

36. Propodeum with a distinct median longitudinal carina on posterior half and with a somewhat rugulose median line on basal half; second abscissa of radius more than twice as long as the first; flagellar segments of antennae but very little longer than broad; legs usually reddish yellow or brown with only the coxae blackish------ 34. **nitidus** (Provancher).

Propodeum smooth and polished without a median carina on posterior half and not rugulose along the median line basally; second abscissa of radius not twice the first; flagellar segments of antennae considerably longer than broad; usually all coxae, trochanters, and more or less of all femora black------------------------------ 35. **tychii**, new species.

37. Second abdominal tergite more or less striate, the third entirely smooth and polished; antennae not stout, all flagellar segments much longer than broad; radius going practically to extreme apex of wing, the third cubital cell scarcely as wide at apex as the second discoidal; abdomen black except more or less of the second and third tergites; antennae normally 29 to 33-segmented-------------------- 36. **pini**, new species.

Second and third abdominal tergites somewhat striate, the latter weakly so and, rarely, entirely smooth; antennae stout, most of the flagellar segments but little or no longer than broad; radius attaining wing margin decidedly before apex of wing; third cubital cell broader at apex than second discoidal cell; abdomen usually mostly ferruginous, with only the first tergite and a median spot on second black; antennae normally 32 to 37 segmented-------------------------------------- 38.

38. Third abscissa of radius as long as last abscissa of cubitus; all segments of antennal flagellum distinctly longer than broad; posterior tibiae wholly black---------------------------------- 37. **sesiae**, new species.

Third abscissa of radius distinctly shorter than last abscissa of cubitus and scarcely as long as first and second abscissae of radius combined; some segments of antennal flagellum not distinctly longer than broad; posterior tibiae fuscous only at apex-------- 38. **nevadensis** (Ashmead).

39. Second abdominal tergite almost smooth, strongly shining and provided with two distinct abbreviated furrows that set off a basal median area, and usually with two longitudinal furrows laterally; third, fourth, and fifth tergites granular, subopaque; antennae shorter than the body, normally 20 to 24 segmented; wings faintly dusky basally; ovipositor sheaths as long as, or a little longer than, the abdomen; a small yellowish species with a few dusky markings on thorax.
39. **thurberiphagae**, new species.

Second abdominal tergite not as above, usually more strongly sculptured than the following; otherwise not combining all the above characters- 40.

40. Antennae slender, normally 22 to 29-segmented, most of the flagellar segments twice as long as thick, the basal segments of flagellum more than twice as long as thick and not at all thicker, sometimes more slender, than the apical segments; wings perfectly clear hyaline with not even a suggestion of duskiness; radius arising much before middle of stigma; propodeum smooth and polished; ovipositor sheaths as long as the abdomen or slightly shorter; legs bright yellow------------------- 41.

Antennae not as above; if apparently so, then not that combination of characters------------------------------------------------ 43.

41. Abdomen very finely sculptured, smooth laterally; second tergite minutely striato-punctate, the following weakly punctate, strongly shining; antennae normally 22 to 24-segmented; abdomen usually yellow.
40. **pityophthori**, new species.

Abdomen coarsely sculptured; suturiform articulation very broad, foveolate; 'antennae normally 26 to 29-segmented; abdomen largely black above------------------------------------------------------ 42.

42. Abdomen, especially second tergite, strongly longitudinally rugulose, the second tergite usually with a complete median longitudinal raised line; parapsidal grooves thickly hairy anteriorly as well as posteriorly; abdomen black above, more or less yellow medially on third, fourth and fifth tergites------------------------------ 41. **laemosacci**, new species.

Abdomen, coarsely granular; parapsidal grooves not thickly hairy anteriorly; abdomen blackish above, yellow laterally.
42. **metacomet** Viereck.

43. Wings long and rather narrow, uniformly somewhat infumated, the wing membrane abnormally thickly hairy over its entire surface; cubitus and subdiscoideus nearly parallel, the second discoidal cell scarcely broadening apically; radial cell very long, the radius going to extreme apex of wing; propodeum entirely finely rugulose; antennae slender, normally more than 40-segmented; ovipositor sheaths as long as the abdomen or slightly longer--------------------- 43. **atricollis** (Ashmead).

Wings not as above; otherwise not that combination of characters---- 44.

44. Propodeum entirely, except at extreme base, rugulose; most of the flagellar segments of antennae scarcely longer than broad; abdomen beyond third tergite very faintly, almost indistinctly, sculptured; thorax mostly yellow------------------------------------------------------ 45.

Propodeum usually smooth and polished, although often with short diverging ridges medially behind, and sometimes very delicately punctate or faintly minutely reticulate over a large part of its surface-------- 46.

45. Ovipositer sheaths considerably longer than the abdomen; antennae normally 33 to 36-segmented; second abdominal tergite rather evenly finely sculptured, without a rugose area on basal middle.
44. **analcidis** (Ashmead).

Ovipositor sheaths a little shorter than the abdomen; antennae normally 29 to 32-segmented; second abdominal tergite with an irregularly rugulose area on basal middle----------------------- 45. **podunkorum** Viereck.

46. Ovipositor sheaths not half as long as the abdomen---------------- 47.

Ovipositor sheaths more than half as long as the abdomen----------- 50.

47. Head, including the face, black; either the frons completely smooth and polished or the parapsidal grooves thickly hairy----------------- 48.

At least the face yellow; parapsidal grooves sparsely hairy; frons finely reticulately sculptured--------------------------------------- 49.

48. Parapsidal grooves thickly hairy; frons closely punctate and opaque; thorax stout; head with pale yellow inner and superior orbital lines; propodeum without a median longitudinal carina; antennae usually 24 to 29-segmented---------- 20. **pygmaeus** (Provancher).

Parapsidal grooves sparsely hairy; frons smooth and polished; thorax slender; head wholly black, without pale orbital lines; propodeum with a complete or nearly complete median longitudinal carina; antennae usually 28 to 32-segmented---------- 23. **meromyzae** (Gahan).

49. Second abdominal tergite very finely punctate; third and following tergites very faintly so, almost polished; antennae usually 29 to 33-segmented---------- 46. **montowesi** Viereck.

Abdomen closely granular above, opaque or subopaque; antennae normally 34 to 40-segmented---------- 47. **cephi** Gahan.

50. All coxae black; remainder of legs more or less blackish; head including face, black; thorax black; abdomen usually red, short, broad oval, rugulose on second tergite, granular on third, fourth and fifth tergites; antennae normally 25 to 29-segmented; ovipositor sheaths about as long as the abdomen beyond first segment---------- 48. **hemimenae** Rohwer.

Coxae yellow, rarely posterior coxae somewhat infuscated, and then not agreeing entirely with the above---------- 51.

51. Propodeum smooth and polished, usually with a complete or nearly complete median longitudinal carina; abdomen strongly sculptured, the second tergite irregularly rugose medially and usually much shorter than the third; wings decidedly infuscated; stigma dark brown; second abscissa of radius usually much more than twice the first; antennae normally 34 to 40-segmented; malar space about as long as first segment of antennal flagellum; ovipositor sheaths about as long as the abdomen, not distinctly longer---------- 49. **oenotherae**, new species.

Propodeum without a median carina, although usually with a stub of a carina at apex; otherwise not exactly as above---------- 52.

52. Ovipositor sheaths at most as long as the abdomen beyond first tergite---------- 61.

Ovipositor sheaths as long as the abdomen or longer---------- 53.

53. Second abdominal tergite finely granular or punctate, never strongly rugose; third and following tergites very delicately, usually very faintly sculptured, strongly shining; suturiform articulation fine, straight, the second tergite not emarginate medially; antennae stout, the segments of the apical half of flagellum scarcely longer than broad; malar space about as long as first flagellar segment; wings very nearly hyaline---------- 54.

Second to fifth or sixth abdominal tergites usually granular, the second often more or less rugose; if abdomen is not distinctly granular on third and following tergites the antennae are more slender, or the malar space is much shorter than the first flagellar segment; at least not combining all the above characters---------- 56.

54. Ovipositor sheaths about as long as the body or nearly; abdomen usually black above except for the suturiform articulation and a lateral spot at base of second tergite, which are yellow; antennae normally 26 to 29-segmented---------- 50. **papaipemae** Gahan.

Ovipositor sheaths about as long as the abdomen; second and third tergites usually yellowish; remainder of abdomen more or less blackish---------- 55.

55. Suturiform articulation distinctly minutely foveolate; face yellow; antennae normally 29 to 32-segmented---------- 51. **apicatus** (Provancher).

Suturiform articulation very fine, weakly impressed, not foveolate; face brownish black; antennae normally 24 to 27-segmented.

52. **nanus** (Provancher).

56. Second abscissa of discoideus as long as the recurrent vein; wings somewhat fuscous, the stigma yellow; abdomen strongly granular above, the second tergite more or less rugulose; suturiform articulation rather broad, foveolate, and somewhat arcuate, the second tergite somewhat emarginate behind; flagellar segments of antennae rather stout, most of them only a little longer than broad; malar space about as long as first flagellar segment------------------------------------------ 53. **mellitor** (Say).

Second abscissa of discoideus not as long as the recurrent vein; otherwise not agreeing completely with the above------------------------------------------ 57.

57. Propodeum finely punctate or granular over its posterior half, and with a median carina posteriorly; abdomen granular on the second to sixth tergites, the second usually with an irregularly rugose area on basal middle; segments of the antennal flagellum mostly but very little longer than broad------------------------------------ 54. **nigropectus** (Provancher).

Propodeum not punctate over posterior half, although usually with a short median ridge posteriorly and a few lateral ridges diverging from this-- 58.

58. Transverse diameter of the opening between clypeus and mandibles scarcely greater than the distance between this opening and the eye; malar space as long, or nearly, as first segment of antennal flagellum; ovipositor sheaths very slender, but broadening rather conspicuously near tip. 55. **furtivus** (Fyles).

Transverse diameter of the opening between clypeus and mandibles much greater than the distance between this opening and the eye; malar space much shorter than first segment of antennal flagellum------------- 59.

59. Ovipositor sheaths very nearly as long as the entire body; face usually blackish; abdomen usually mostly black----- 56. **tachypteri**, new species.

Ovipositor sheaths about as long as the abdomen; face yellow; abdomen usually mostly yellow------------------------------------------ 60.

60. Second abdominal tergite usually with a shining irregularly rugose area on basal middle; third and following tergites granular; abdomen rather broad-oval; first and second segments of antennal flagellum usually about equal and usually twice as long as thick, the apical segments of flagellum slender, usually twice as long as thick; first abdominal tergite, a median spot at base of second and more or less of the apical tergites usually blackish------------------------------ 57. **variabilis** (Provancher).

Second abdominal tergite not as above; the tergites beyond third usually not granular, very faintly sculptured and shining; first segment of antennal flagellum usually decidedly longer than second, the second not twice as long as thick; most of the flagellar segments beyond second but very little longer than broad, the apical segments stout; abdomen usually entirely yellow-------------------------- 58. **sanninoideae** Gahan.

61. Segments of antennal flagellum very stout, beyond the first scarcely as long as broad; second abdominal tergite very finely punctate, the following tergites exceedingly faintly sculptured and strongly shining; propodeum finely punctate on posterior half-------- 59. **hobomok** Viereck.

Segments of antennal flagellum not so stout---------------------------- 62.

62. Malar space as long as first segment of antennal flagellum; transverse diameter of opening between clypeus and mandibles scarcely greater than distance from this opening to the eye; stigma, including its costal margin largely yellow, brown at apex; second abscissa of radius much more than twice the first; propodeum usually minutely punctate or reticulate

over most of its surface; abdomen granular on the second to sixth tergites; antennae normally 29 to 35-segmented---- 60. **caulicola** Gahan.

Malar space not as long as first segment of antennal flagellum; rarely nearly so, but then not combining all the above characters-------- 63.

63. Second abdominal tergite very finely sculptured, usually a little striate medially, the following almost smooth, exceedingly faintly, almost indistinctly, punctate; propodeum smooth and polished with a stub of a median carina posteriorly---------------------------------------- 64.

Second abdominal tergite more coarsely sculptured, usually with an irregularly rugose area on basal middle, the following tergites granular; rarely the third and those beyond nearly smooth, but then the propodeum is minutely punctate or reticulate over most of its surface-------- 65.

64. Coxae more or less infuscated above; face blackish; wings rather strongly dusky; ovipositor sheaths about as long as the abdomen beyond 1st tergite ------------------------------------ 61. **niger** (Provancher).

Coxae entirely pale yellow; face yellow, wings nearly hyaline. 62. **aequalis** (Provancher).

65. Antennae normally 23 to 29-segmented, shorter than the body, the segments of apical half of flagellum but little longer than wide; second abdominal tergite usually as long as the first and longer than the third; malar space very nearly as long as first flagellar segment; propodeum usually faintly punctate over its posterior half---- 63. **argutator** (Say).

Antennae usually as long as the body, the flagellar segments much longer than broad; second abdominal tergite usually shorter than the first and scarcely as long as the third------------------------------------ 66.

66. Propodeum finely punctate or reticulate or very minutely granular over most of its surface, more coarsely roughened medially and with a median ridge posteriorly; abdomen beyond third tergite very delicately sculptured, irregularly transversely lineolated------ 64. **geraei**, new species.

Propodeum smooth and polished, with only a stub of a median longitudinal ridge posteriorly and with some short lateral carinae diverging from this; abdomen usually granular on the second to sixth tergites------------ 67.

67. Antennae normally 34 to 40-segmented; malar space usually distinctly more than half the transverse diameter of the opening between clypeus and mandibles ---------------------------------------------------- 68.

Antennae normally 24 to 32-segmented; malar space scarcely half the transverse diameter of the opening between clypeus and mandibles. 57. **variabilis** (Provancher).

68. Suturiform articulation slightly arcuate, the second tergite a little emarginate medially behind; first segment of antennal flagellum usually not twice as long as wide; first tergite and a median basal spot on second black; thorax usually mostly blackish---------- 65. **lutus** (Provancher).

Suturiform articulation straight, the second tergite not at all emarginate behind; first segment of antennal flagellum twice as long as wide; second tergite entirely yellow, without a blackish spot medially at base. 66. **cerambycidiphagus**, new species.

69. Dorsum of abdomen mostly smooth and polished, the sculpture when present very rarely extending to the third tergite; propodeum smooth and polished, sometimes with a median carina or a stub of a median ridge at apex; frons usually smooth and polished; if sculptured, the face and coxae black; face very rarely yellow; if so, then the abdomen is entirely smooth and polished---------------------------------------- 70.

Dorsum of abdomen mostly sculptured; very rarely not distinctly sculptured beyond second tergite, but then frons is finely reticulately sculptured and face and coxae are yellow; face and coxae very rarely black and then abdomen is distinctly sculptured........................ 90.

70. Opening between clypeus and mandibles unusually large, its transverse diameter as long as, or longer than, the distance from lower margin of antennal foramina to lower margin of clypeus; propodeum with a complete median longitudinal carina; posterior tarsi short and stout, shorter than their tibiae........................ 71.

Opening between clypeus and mandibles not so large; at least not agreeing entirely with the above........................ 72.

71. Wings strongly infuscated; last segment of hind tarsi very large, broadening strongly toward apex and much longer than second tarsal segment; antennae 25 to 27 segmented.............. 15. **gastroideae** (Ashmead).

Wings hyaline or very nearly; last segment of hind tarsi normal, not broadening strongly toward apex and not longer than second tarsal segment; antennae usually 21 to 23 segmented... 16. **brachyurus** (Ashmead).

72. Second abdominal tergite with conspicuous, more or less triangular areas of weaker chitinization laterally opposite the broad membranous margins of first tergite; abdomen, including first tergite, wholly smooth and polished, propodeum completely polished without a stub of a median ridge at apex........................ 73.

Second abdominal tergite without such membranous areas laterally; first abdominal tergite usually more or less sculptured at apex; propodeum most frequently, though not always, with a stub of a carina at apex... 76.

73. Antennae usually 23 to 26 segmented, usually shorter than the body; third abscissa of radius distinctly longer than the first and second abscissae combined and about twice as long as the second; last abscissa of cubitus distinctly longer than the preceding abscissa; wings usually rather strongly dusky........................ 74.

Antennae usually 28 to 32 segmented, longer than the body; third abscissa of radius not distinctly longer than the first and second combined and not nearly twice as long as the second; last abscissa of cubitus not distinctly longer than the preceding; wings faintly infuscated.......... 75.

74. Head, thorax, and abdomen yellowish, sometimes with fuscous markings; legs yellow; second abdominal tergite usually as long as third, or nearly........................ 29. **rudbeckiae**, new species.

Head, thorax, and abdomen, black; legs black; second abdominal tergite usually much shorter than third.............. 30. **tenuiceps**, new species.

75. Head and thorax black; abdomen mostly black; legs more or less blackish........................ 17. **melanaspis** (Ashmead).

Head, thorax, and abdomen mostly yellowish; legs yellowish.
18. **juncicola** (Ashmead).

76. Frons entirely, and usually the vertex to some extent, closely minutely punctate or reticulate and opaque; parapsidal grooves completely thickly hairy; head black with contrasting yellow orbital lines; thorax short and stout, black; wings rather strongly infuscated.................. 77.

Frons usually smooth and polished, rarely with faint sculpture just above insertion of antennae; at least not exactly as above.................. 78.

77. Second abdominal tergite usually smooth and polished, and provided with two distinct short oblique foveolate impressions medially toward base; antennae usually 21 to 24 segmented; middle lobe of mososcutum with scattered pubescence arising from its surface anteriorly.
19. **politiventris** (Cushman).

Second abdominal tergite usually finely sculptured over nearly its entire surface and without such impressions toward the base; antennae normally 24 to 29-segmented; surface of middle lobe entirely destitute of pubescence although the long hairs arising in the parapsidal grooves lie upon the lobes ---------- 20. pygmaeus (Provancher).

78. Head thin antero-posteriorly, hardly longer at the intersection of the antennae than at the clypeus, the face not strongly receding; thorax rather stout; propodeum completely smooth and polished, without even a stub of a median ridge posteriorly; wings rather strongly infuscated on basal half ---------- 79.

Head not thin, rather prominent just below insertion of antennae, the face receding; propodeum most frequently with a distinct short stub of a median ridge at apex ---------- 81.

79. Parapsidal grooves rather thickly hairy posteriorly; all coxae and more or less of remainder of legs, black; first abscissa of radius usually nearly as long as first intercubitus and much more than half the second abscissa of radius ---------- 21. connecticutorum Viereck.

Parapsidal grooves exceedingly sparsely hairy ---------- 80.

80. Second abdominal tergite usually with a rather prominent polished basal median area and with some sculpture adjoining this; coxae and more or less of remainder of legs black ---------- 31. nuperus (Cresson).

Second abdominal tergite, like remainder of abdomen, completely polished; legs, including all coxae, usually uniformly yellowish-red or reddish-brown ---------- 32. curtus (Provancher).

81. Abdomen wholly smooth and polished, the second tergite with two short oblique furrows setting off a basal median area; parapsidal furrows thickly hairy; head more than usually thick antero-posteriorly; antennae usually 29 to 32 segmented, tapering distinctly toward tip; face yellow; body usually mostly yellow; legs yellow, posterior coxae sometimes a little infuscated ---------- 22. psilocorsi Viereck.

Abdomen rarely entirely smooth and polished, and then not agreeing completely with the above characters ---------- 82.

82. Legs including all coxae bright yellow; antennae never stout, all flagellar segments decidedly longer than broad; suturiform articulation always very fine; wings frequently hyaline ---------- 83.

Legs dark brown or blackish; coxae black or blackish; wings distinctly infuscated ---------- 88.

83. Propodeum usually with a complete or nearly complete median longitudinal carina; second and third tergites finely sculptured; first abdominal tergite mostly rugose ---------- 23. meromyzae (Gahan).

Propodeum smooth and polished with only a short stub of a median ridge posteriorly; third tergite always entirely smooth and polished ---------- 84.

84. Abdomen entirely polished with no indication of sculpture; wings perfectly clear hyaline; face yellow; thorax and abdomen usually entirely yellow ---------- 27. angelesius (Provancher).

Second abdominal tergite nearly always a little sculptured; face black; thorax and more or less of abdomen black ---------- 85.

85. First abscissa of radius about as long as inner side of stigma and nearly as long as first intercubitus; second abscissa of radius not twice the first; wings distinctly fuscous on basal two-thirds; flagellar segments of antennae not twice as long as thick ---------- 67. cinctus (Provancher).

Not agreeing entirely with the above ---------- 86.

86. Propodeum somewhat sculptured medially at base and with a distinct median ridge on apical third; posterior tarsi scarcely as long as their tibiae, the last tarsal segment fully as long as the second, and stout
26. **uncas** Viereck.

Propodeum perfectly smooth and polished except for an exceedingly short, often indistinct, stub of a median ridge at apex; posterior tarsi longer than their tibiae, the last tarsal segment not nearly as long as the second ---------- 87.

87. Antennae very slender, normally 27 to 32-segmented, all flagellar segments at least twice as long as broad; head entirely black
28. **auripes** (Provancher).

Antennae usually 33 to 36-segmented, the flagellar segments mostly less than twice as long as broad; head usually with very narrow inner and superior ferruginous orbital lines---------24. **nigridorsum** (Ashmead).

88. Posterior tarsi stout, the last tarsal segment fully as long as the second and more than half the metatarsus; abdomen slender; first tergite long and narrow, broadening gradually from base and about twice as long as broad at apex; second tergite at most with faint sculpturing medially; suturiform articulation very delicate; stigma large; abdomen black------- 89.

Posterior tarsi more slender, the last tarsal segment shorter than the second and not more than half the metatarsus; otherwise not as above---- 90.

89. Abdomen completely polished; wings strongly infuscated.
68. **wawequa** Viereck

Abdomen with second tergite a little striate medially; wings slightly dusky on basal two-thirds-------------- 25. **ashmeadi**, new name.

90. Second and third abdominal tergites rather evenly striate; suturiform articulation broad, coarsely foveolate; last abscissa of radius shorter than first and second combined; propodeum with a median carina on apical half; all segments of antennal flagellum longer than broad
69. **sulcifrons** (Ashmead).

Third abdominal tergite rarely sculptured and then with only very faint roughening toward base; at least not the above combination of characters---------- 91.

91. Stigma yellow at base and along costal margin; malar space about as long as first segment of antennal flagellum; all flagellar segments longer than broad, the first and second of equal length-------- 33. **hyslopi** Viereck.

Stigma unicolorous, brown---------- 92.

92. Antennae stout, frequently broadening faintly beyond the first flagellar segment, and narrowing again toward apex, most of the flagellar segments but little or no longer than broad; second abscissa of radius usually twice the first; abdomen frequently ferruginous with only first tergite and median spot on second, black---------- 93.

Antennae more slender, all flagellar segments much longer than broad; second abscissa of radius usually distinctly less than twice the first; abdomen black with more or less of second and third tergites pale---- 95.

93. Antennae normally 25 to 30-segmented; propodeum with a median carina on apical half and more or less rugulose on the median line toward base; second abscissa of radius more than twice the first, the third longer than the first and second combined; abdomen with second and third tergites mostly yellowish or red, the remainder black.
34. **nitidus** (Provancher).

Antennae normally 32 to 37-segmented; propodeum not so completely sculptured on the median line; abdomen usually ferruginous with only first tergite and a median spot on second black---------- 94

94. Third abscissa of radius shorter than last abscissa of cubitus and not distinctly as long as first and second abscissae of radius combined; flagellar segments of antennae mostly not longer than broad; posterior tibiae dusky only at apex________________ 38. **nevadensis** (Ashmead).

Third abscissa of radius as long as last abscissa of cubitus and fully as long as the first and second abscissae of radius combined; all flagellar segments of antennae a little longer than broad; posterior tibiae wholly black____________________________________ 37. **sesiae**, new species.

95. Propodeum with a prominent stub of a median ridge on its posterior third; first abscissa of radius not as long as the side of stigma bordering first cubital cell________________________________ 36. **pini**, new species.

Propodeum without a distinct stub of a median carina extending one-third the distance toward base; first abscissa of radius as long as the side of stigma bordering first cubital cell________ 35. **tychii**, new species.

96. Second abdominal tergite almost smooth, strongly shining and provided with two distinct short furrows that set off a basal median area and usually with two longitudinal furrows laterally; third, fourth, and fifth tergites granular; antennae shorter than the body, usually 20 to 24-segmented; radius arising much before middle of stigma; posterior coxae strongly infuscated________________ 39. **thurberiphagae**, new species.

Not agreeing entirely with the above____________________________ 97.

97. Antennae very slender, usually 22 to 29-segmented, all of the flagellar segments fully twice as long as thick, the basal segments not thicker than the apical segments, the antennae not tapering toward tip; wings perfectly clear hyaline; stigma long; radius arising much before its middle; propodeum smooth and polished________________________ 98.

Antennae not as above; at least not that combination of characters____ 100.

98. Abdomen very delicately sculptured, smooth laterally; antennae usually 22 to 24-segmented; abdomen usually yellow.
40. **pityophthori**, new species.

Abdomen coarsely sculptured; suturiform articulation very broad, foveolate; antennae usually 26 to 29-segmented; abdomen mostly black above ____________________________________________________ 99.

99. Abdomen, especially second tergite, strongly longitudinally rugose, the second tergite usually with a complete median longitudinal raised line; parapsidal grooves rather thickly hairy anteriorly as well as posteriorly; abdomen black above, more or less yellow medially on third, fourth, and fifth tergites__________________________ 41. **laemosacci**, new species.

Abdomen coarsely granular; parapsidal grooves not thickly hairy anteriorly; abdomen blackish above, yellow laterally_ 42. **metacomet** Viereck.

100. Wings long, uniformly infuscated to apex, the wing membrane abnormally thickly hairy over its entire surface; cubitus and subdiscoideus nearly parallel, the second discoidal cell scarcely broadening apically; radial cell exceptionally long, radius going to extreme apex of wing; propodeum entirely finely rugulose; antennae slender and more than 40-segmented______________________________ 43. **atricollis** (Ashmead).

Wings not agreeing with the above characterization________________ 101.

101. All coxae and trochanters black; more or less of remainder of legs, especially posterior tibiae, blackish; head, including face, deep black; wings strongly infuscated; thorax black; abdomen usually more or less red____________________________________ 48. **hemimenae** Rohwer.

Coxae yellow, rarely a little infuscated; face very rarely brownish-black____________________________________________________ 102

102. Propodeum, except at extreme base, rugulose; most flagellar segments but very little longer than broad; body usually yellowish; abdomen only very faintly sculptured beyond second tergite ---------- 103.

Propodeum usually smooth and polished, although often with diverging ridges medially, and sometimes delicately punctate or reticulate over most of its surface ---------- 104.

103. Second abdominal tergite with an irregularly rugose area on basal middle; antennae usually 28 to 32-segmented ---------- 45. **podunkorum** Viereck.

Second abdominal tergite rather evenly finely sculptured; antennae usually 32 to 36-segmented ---------- 44. **analcidis** (Ashmead).

104. Propodeum faintly reticulate on its posterior half; sometimes more distinctly granular over its entire surface; thorax never wholly black ---------- 105.

Propodeum smooth and polished, with no indication of such reticulation ---------- 108.

105. Second abscissa of radius much more than twice the first; radius going to extreme apex of wing, the third abscissa of radius almost on a straight line with the second; wings distinctly somewhat infuscated, the stigma usually yellow; antennae rather slender, usually 30 to 36-segmented; body entirely yellow, very rarely with propodeum and first tergite dusky; ocell-ocular line not more than twice the diameter of an ocellus ---------- 60. **caulicola** Gahan.

Second abscissa of radius usually not more than twice the first, and usually making a distinct angle with the second ---------- 106.

106. Antennae normally 23 to 29-segmented; second abdominal tergite usually fully as long as the first and longer than the third; propodeum and first abdominal tergite usually infuscated; mesonotal lobes often more or less blackish ---------- 63. **argutator** (Say).

Antennae usually 27 to 37-segmented; second abdominal tergite very rarely longer than third ---------- 107.

107. Flagellar segments of antennae slender; antennae composed of 27 to 33 .segments; abdomen beyond 3d tergite usually only very faintly sculptured; propodeum and first abdominal tergite usually yellow; head, sometimes including part of face, and anterior parts of mesonotum, usually blackish ---------- 64. **geraei**, new species.

Flagellar segments mostly only a little longer than broad; antennae normally composed of 32 to 37 segments; third to fifth abdominal tergites granular and opaque; propodeum and first abdominal tergite, and usually venter of thorax, black ---------- 54. **nigropectus** (Provancher).

108. Abdomen not or only indistinctly sculptured beyond third tergite, strongly shining, suturiform articulation very fine ---------- 109.

Abdomen granular on second to fifth tergites; suturiform articulation often rather broad, foveolate ---------- 115.

109. Antennae stout, most of the flagellar segments but little or no longer than broad ---------- 110.

Antennae slender, flagellar segments much longer than broad; face yellow; abdomen mostly yellow ---------- 112.

110. Suturiform articulation usually finely foveolate; antennae usually 28 to 33-segmented; face yellow; abdomen usually largely ferruginous, blackish at base and apex; frons and vertex mostly ferruginous, black only medially ---------- 51. **apicatus** (Provancher).
59. **hobomok** Viereck.

Suturiform articulation not distinctly foveolate; antennae usually 24 to 29-segmented; face usually brownish-black; frons and vertex wholly black ---------- 111.

111. First abdominal tergite with a foveolate groove just inside the lateral margins; abdomen black, with only the suturiform articulation and a lateral spot on second tergite yellow; segments of antennal flagellum all a little longer than broad; posterior coxae more or less infuscated. 50. **papaipemae** Gahan.

First abdominal tergite without a distinct foveolate groove inside lateral margins, but with elongate apical lateral pits; abdomen with second and third tergites mostly pale; most segments of antennal flagellum not distinctly longer than broad; all coxae yellow___ 52. **nanus** (Provancher).

112. Face yellow; all coxae bright yellow; abdomen usually mostly yellow__ 113.

Face brownish-black; posterior coxae more or less infuscated above; abdomen mostly blackish____________________ 61. **niger** (Provancher).

113. Third cubital cell long, the last abscissa of cubitus much longer than the preceding, the third abscissa of radius considerably longer than the first and second abscissae combined; second abscissa of radius usually not twice the first; abdomen black except the suturiform articulation and second tergite laterally____________________ 70. **canadensis** (Ashmead).

Last abscissa of cubitus not distinctly longer than the preceding; third abscissa of radius not longer than first and second abscissae combined; second abscissa of radius at least twice the first; abdomen mostly yellow____________________________________________________ 114.

114. Propodeum very smooth and polished with only an exceedingly short stub of a median ridge at apex; first flagellar segment more than twice as long as broad and distinctly longer than the scape; scape yellow. 46. **montowesi** Viereck.

Propodeum with a median carina extending nearly half-way to the base; first flagellar segment of antennae nearly twice as long as broad, but scarcely as long as the scape; scape black_ 62. **aequalis** (Provancher).

115. Malar space one-third as long as the eye height; ocelli very small, the ocell-ocular line three times as long as the diameter of an ocellus; second abdominal tergite considerably shorter than third; sixth tergite, as well as all the preceding, sculptured; propodeum usually with a nearly complete median longitudinal carina; antennae usually 33 to 40-segmented________________________________ 49. **oenotherae**, new species

Malar space not nearly one-third the eye-height; ocell-ocular line not three times as long as the diameter of an ocellus; second abdominal tergite usually as long as the third; sixth tergite practically always completely polished____________________________________________ 116.

116. Distance between clypeal foveae more than twice as long as malar space; antennae usually 24 to 32-segmented, very rarely with 33 or 34 segments__________________________________________________________ 117.

Distance between clypeal foveae not distinctly twice as long as malar space; or, if apparently as long, then with antennae 34 to 40-segmented; antennae rarely with less than 33 segments____________________ 121.

117. Head, including face black or brownish-black______________________ 118.

Face pale yellow; frons and vertex mostly yellow__________________ 119.

118. Thorax and abdomen entirely or mostly yellow; propodeum impressed, almost grooved along the median line, with some transverse rugae in the depression; thorax not stout, about twice as long as high, viewed laterally________________________________________ 71. **konkapoti** Viereck.

Thorax and abdomen mostly black; propodeum smooth and polished except for a stub of a median ridge at apex, not impressed along the median line; thorax stout________________ 56. **tachypteri**, new species

119. Second to fifth abdominal tergites evenly granular and opaque, the second not longitudinally rugulose and without a median irregularly rugose shining area; ocell-ocular line a little more than twice the diameter of of an ocellus; last abscissa of radius scarcely as long as first and second abscissae combined---------------------- 72. **rhyssemati** (Ashmead).

Second abdominal tergite usually with a median irregularly rugose shining area at base, or longitudinally rugose; fourth and fifth tergites usually much more weakly sculptured and shining; last abscissa of radius usually a little longer than first and second abscissae combined; ocell-ocular line scarcely twice as long as greatest diameter of an ocellus--120.

120. Thorax, viewed laterally, twice as long as high; antennae usually 31 to 34-segmented, the first flagellar segment usually distinctly longer than the second; abdomen usually entirely yellow beyond first tergite. 58. **sanninoideae** Gahan.

Thorax more compact, not twice as long as its greatest height; antennae usually 24 to 32-segmented, the first and second flagellar segments usually of equal length and twice as long as broad; abdomen usually with first tergite, median spot on second, and more or less of apical tergites blackish------------------------57. **variabilis** (Provancher).

121. Recurrent vein not distinctly longer than second abscissa of discoideus, and but very little longer than the portion of cubitus between recurrent and first intercubitus; antennae rather stout, none of the flagellar segments twice as long as broad; second tergite usually slightly emarginate at the middle posteriorly; wings usually infuscated, with the stigma yellow--------------------------------------------53. **mellitor** (Say).

Recurrent vein longer than second abscissa of discoideus and usually twice as long as the portion of cubitus between recurrent and first intercubitus; antennae usually more slender, with at least the basal flagellar segments and the terminal segments twice as long as broad----- 122.

122. Last segment of posterior tarsi as long as the second; second abscissa of radius more than twice the first; measured on the cubitus, the third cubital cell shorter than the second; second abdominal tergite not irregularly strongly rugose on basal middle; antennae 34 to 40-segmented; thorax long, not stout--------------------------------47. **cephi** Gahan.

Last segment of posterior tarsi shorter than second; at least not exactly as above---------------------------------------------------- 123.

123. Second abdominal tergite with an irregularly rugose shining area on basal middle; antennae ususally 35 to 42-segmented; malar space scarcely more than half the distance between clypeal foveae--------------- 124.

Second abdominal tergite without such irregularly rugose area on basal middle, evenly granular or somewhat longtitudinally sculptured medially------------------------------------------------- 125.

124. Suturiform articulation straight, the second abdominal tergite not at all emarginate behind; second abdominal tergite, like remainder of abdomen, usually entirely yellow------ 66. **cerambycidiphagus**, new species.

Suturiform articulation broadly a little emarginate behind; second tergite usually with a black median spot. and more or less of remainder of abdomen usually blackish or fuscous------------65. **lutus** (Provancher).

125. Face more or less blackish; second abscissa of radius not distinctly twice the first; thorax wholly black------------73. **cookii** (Ashmead).

Face yellow; second abscissa of radius usually distinctly more than twice the first----------------------------------55. **furtivus** (Fyles).

### 1. MICROBRACON QUINNIPIACORUM Viereck

*Microbracon quinnipiacorum* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), p. 207.

*Type.*—In the Connecticut Agricultural Experiment Station at New Haven.

The antennae of the type are 31-segmented and slender, the basal flagellar segments twice, or nearly twice, as long as broad; frons, vertex, mesoscutum, scutellum, pro-, meso-, and metapleura, propodeum and dorsum of abdomen entirely, uniformly finely punctate or reticulate and opaque; parapsidal grooves pubescent; the surface of the middle lobe of mesoscutum bare; propodeum with a stub of a median ridge at apex; wings only very slightly dusky; second abscissa of radius at least twice as long as the first, the first and second abscissae combined scarcely as long as the third; second abdominal tergite much longer than the third; in the type the ovipositor sheaths project scarcely the length of the first abdominal tergite. Ferruginous; head, thorax and base of abdomen more or less marked with blackish. A small species, about 2 mm. in length.

*Distribution.*—Connecticut, Maryland.

*Host.*—Unknown.

Known only from the type, and one female specimen in the United States National Museum, labeled "Md., Collection Ashmead."

### 2. MICROBRACON PUNCTATUS, new species

*Female.*—Length 2.8 mm. Head rather thick antero-posteriorly at insertion of antennae, the face receding somewhat below; face including clypeus, frons, and vertex finely closely punctate and opaque; frons with a distinct median groove from anterior ocellus to the antennae; antennae 28-segmented, nearly or quite as long as the body, the two basal flagellar segments about twice as long as wide, all the following much longer than broad; mesoscutum and scutellum, pro-, meso- and metapleura, propodeum, and posterior coxae all finely evenly punctate and opaque; propodeum with a distinct complete median longitudinal groove; pubescence on mesonotum sparse and restricted to the parapsidal grooves; second abscissa of radius more than twice as long as the first, the latter about half the first intercubitus; third abscissa of radius about as long as the first and second abscissae combined; last abscissa of cubitus about as long as the preceding abscissa; the portion of cubitus between recurrent and first intercubitus very short, the recurrent nearly interstitial with first intercubitus; abdomen ovate; first tergite evenly punctate, opaque; the second and third finely punctate or minutely granular, the posterior tergites much more weakly so and more shining; ovipositor sheaths as long as the abdomen beyond first tergite.

Ferruginous; frons, vertex and occiput piceous; antennae yellowish below toward base, brownish to brownish-black above and apically; wings hyaline, stigma brown; legs ferruginous.

*Type.*—Cat. No. 26661, U.S.N.M.

*Type-locality.*—Nassau County, New York.

*Host.*—The type is labeled "With larva of *Listronotus latiusculus.*"

Described from a single specimen taken by F. H. Chittenden.

### 3. MICROBRACON SPHENOPHORI, new species

Fig. 6

*Female.*—Length 3 mm. Head very nearly as long antero-posteriorly as high; eyes rather small, hardly more than half as long as the height of head; distinctly though sparsely hairy; malar space short, less than half the transverse diameter of the opening between clypeus and mandibles, which is about equal to the distance from base of antennae to clypeus; face and frons closely minutely punctate and opaque, the vertex faintly punctate; vertex and temples broad; frons without a distinct median groove descending from median ocellus; ocell-ocular line more than three times the diameter of an ocellus; antennae missing beyond 19th segment; first flagellar segment about twice as long as broad, much longer than the second, the following but very little longer than broad; mesoscutum and scutellum very faintly punctate, more distinctly so in the region of the parapsidal grooves, shining; anteriorly the mesoscutum is very smooth and shining, not distinctly punctate; pleura entirely, propodeum and posterior coxae, minutely evenly punctate and subopaque; the propodeum with a more or less distinct median furrow; pubescence on mesoscutum very sparse and restricted to the parapsidal furrows; fore wing with radius going nearly to the apex; second abscissa of radius fully twice the first, but the first and second combined less than the third; the first abscissa of radius about half the first intercubitus; last abscissa of cubitus much longer than the preceding; the portion of cubitus between recurrent and intercubitus very short, the recurrent nearly interstitial with first intercubitus; posterior femora rather stout, but little more than three times as long as broad; abdomen long and narrow; first tergite evenly punctate, like the propodeum; the following tergites very minutely punctate, becoming gradually less distinctly so posteriorly, the apical tergites being smooth and shining; ovipositor sheaths as long as the abdomen beyond the first tergite. Entirely yellow including antennae and legs; wings hyaline, stigma and veins yellowish.

*Male.*—Essentially as in the female; the malar space is a little shorter; the antennae are 36-segmented, and the flagellar segments longer than in the female; on the basal half the antennae are yellowish, on the apical half blackish.

*Type.*—Cat. No. 26660, U.S.N.M.

*Type-locality.*—Charleston, Missouri.

*Host.*—*Sphenophorus callosus* Olivier.

Described from three specimens reared by Bagby and Satterthwaite, August 16 to 25, 1917 under Webster No. 17835.

### 4. MICROBRACON GELECHIAE (Ashmead)

Fig. 23

*Bracon gelechiae* Ashmead, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 623.
*Bracon notaticeps* Ashmead, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888) p. 624.
*Bracon*, species Riley and Howard, Insect Life, vol. 2, 1890, p. 349.
*Habrobracon gelechiae* Johnson, Ent. News, vol. 6, 1895, p. 324.
*Bracon*, species Johannsen and Patch, Bull. 195, Maine Agr. Exp. Sta., 1912, p. 243.
*Habrobracon johannseni* Viereck, Proc. U. S. Nat. Mus., vol. 42, 1913, p. 622.
*Habrobracon tetralophae* Viereck, Proc. U. S. Nat. Mus., vol. 42, 1913, p. 623.
*Habrobracon gelechiae* Cushman, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 106.
*Habrobracon johannseni* Cushman, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 107.
*Habrobracon gelechiae* Stearns, Journ. Econ. Ent., vol. 12, 1919, p. 348.

*Type.*—The types of *gelechiae*, *notaticeps*, *johannseni*, and *tetralophae* are all in the United States National Museum, and respectively bear Type Catalogue Nos. 2919, 2920, 14720, and 14721.

The female antennæ normally are 22 to 26-segmented, although very small specimens rarely have as few as 19 or 20 segments in the antennæ; the antennæ of the males are 22 to 27-segmented; the flagellar segments are always much longer than broad, the first being twice as long as broad. The entire body is closely finely punctate and opaque or subopaque; the propodeum is without a distinct stub of a carina posteriorly; the color varies greatly, but the head is nearly always black, with pale inner and superior orbital lines, and the thorax is black; the first abscissa of the radius is almost invariably about as long as the second, and the portion of cubitus between the recurrent and the first intercubitus is fully as long as the recurrent, and in small specimens longer.

*Distribution.*—Throughout the United States.

*Hosts.*—*Gelechia*, species (Ashmead); (*Gelechia*) *Phthorimaea cinerella* Murtfeldt (Ashmead); "oak-leaf skeletonizer" (Ashmead); (*Tetralopha*) *Wanda baptisiella* Fernald (Viereck); "4-spotted oak-leaf tyer;" (*Gelechia*) *Aristotelia roseosuffusella* Clemens (Riley and Howard); *Canarsia hammondi* Riley; *Pyrausta nubilalis* Huebner; *Laspeyresia molesta* Busck (Stearns); *Gelechia hibiscella* Busck; *Phthorimaea operculella* Zeller; *Papaipema*, species in pinks; *Desmia funeralis* Huebner; *Polychrosis viteana* Clemens; and *Archips argyrospila* Walker.

A large quantity of material which is in the United States National Museum has been examined. This includes, in addition to the types, specimens from the hosts listed above and from the following localities: Riley Co., Kansas; Franklin Co., Arkansas; Bentonville, Arkansas (D. Isely). Watertown, Massachusetts (D. H. Craig); Peabody and Wakefield, Massachusetts (D. W. Jones and H. L. Parker); Cedar Point, Maryland; Oswego, New York; Whitesburg, New Jersey (H. B. Scammell); Leesburg, Virginia (L. A. Stearns); Rutherford, New Jersey (E. L. Dickerson); Fairfax County, Virginia (J. F. Strauss); Norfolk, Virginia (F. H. O'Neill); Carlisle, Pennsylvania (P. R. Myers); Northeast, Pennsylvania; Champaign, Illinois. Salineville, Ohio; Agricultural College, Michigan; Spokane, Washington (H. E. Newman); Los Angeles and El Monte, California (J. E. Graf). Most of this material was reared in the Bureau of Entomology under various Chittenden, Quaintance and Webster numbers. There is also a series of this species at the Gipsy Moth Laboratory, reared by R. T. Webber from an unknown tortricid on *Monarda didyma*, at Melrose Highlands, Massachusetts, under Gipsy Moth Laboratory No. 12164 C 21.

### 5. MICROBRACON DIVERSICOLOR (Viereck)

*Habrobracon diversicolor* VIERECK, Ent. News, vol. 32, 1921, p. 174.

*Type.*—In the California Academy of Sciences.

The type of this species has not been seen; but from the original description it appears to be *gelechiae* (Ashmead). However, I prefer to hold the name distinct until an opportunity is presented for an examination of the type.

*Distribution.*—Berkeley, California.

*Host.*—Unknown.

### 6. MICROBRACON ERUCARUM (Cushman)

Fig. 24

*Habrobracon erucarum* CUSHMAN, Proc. U. S. Nat. Mus., vol. 58, 1920, p. 291.

*Type.*—Cat. No. 22870, U.S.N.M.

Near *americanus* (Ashmead) and *gelechiae* (Ashmead), but separable from these by the characters given in the foregoing table. Usually entirely black except for very narrow, sometimes mostly obsolete, pale inner orbital lines, the venter of the abdomen, which is usually yellow, and usually more or less of the tibiae, which are somewhat brownish; the mesonotum, pleura, and propodeum are faintly closely punctate; the scutellum almost polished; the abdomen beyond the second tergite is smooth and shining, only faintly minutely reticulate; the radial cell is exceptionally small, measured along the wing margin but little longer than the stigma; the first abscissa of radius is usually longer than the second; the only entire female antenna seen has 22 segments, that of the male 25.

*Distribution.*—Utah; Colorado; Arizona.

*Host.*—*Euxoa*, species.

In addition to the type series the United States National Museum has one specimen from Chiric Mountains, Arizona (H. G. Hubbard); and another from Colorado (C. F. Baker).

### 7. MICROBRACON AMERICANUS (Ashmead)

*Trachyusa americana* ASHMEAD, Bull. Colorado Biol. Assoc., 1, 1890, p. 18.
*Habrobracon americanus* GAHAN, Proc. U. S. Nat. Mus., vol. 55, 1919, p. 123.

*Type.*—Cat. No. 13421, U.S.N.M.

Although in his description Ashmead stated that he had but one specimen, and that a male, the specimen in the National Museum labeled "type" is a female. It agrees in every detail with Ashmead's description and I have no doubt whatever that it is the specimen which he had before him. The face, frons, vertex, temples, even occiput to some extent, and the entire thorax, minutely punctate or reticulate and opaque; antennae of type 23-segmented; antennae of two other specimens, one female and one male, likewise 23-segmented, not tapering toward tip; the two basal flagellar segments twice as long as broad; middle lobe of mesoscutum destitute of pubescence medially; propodeum with a distinct median carina on its posterior third or half; abdomen beyond second tergite a little more strongly punctate and less shining than in *erucarum;* radial cell short, the radius attaining wing margin much before the apex; second abscissa of radius distinctly longer than first, and at least as long as first intercubitus; the portion of cubitus between recurrent vein and first intercubitus decidedly shorter than recurrent; ovipositor sheaths projecting much less than half the length of the abdomen beyond apex of the last dorsal segment; head black except for narrow superior orbital lines and a yellowish spot on cheeks adjoining the malar space; thorax and abdomen mostly or entirely black; coxae black; remainder of legs more or less black; one male in the National Museum has the abdomen almost entirely red, and the antennae 22-segmented.

*Distribution.*—Colorado.

*Host.*—Unknown.

In addition to the type there are three specimens, one female and two males, in the United States National Museum, all from Colorado, the female labeled "Colo. 2075," the two males "Colo. 413."

### 8. MICROBRACON CUSHMANI, new name

Fig. 17

*Habrobracon variabilis* CUSHMAN, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 103 (not Provancher).

*Type.*—Cat. No. 18275, U.S.N.M.

Separated from *xanthonotus* and *platynotae* by the antennae, which, especially in the female, are stout and taper toward the tip; and by the paler head and thorax. It is further distinguished from *platynotae* by the usually coarser longitudinal sculpture of the second tergite, and from *xanthonotus* by the longer ovipositor sheaths, which are a little more than half as long as the abdomen. Head and thorax entirely finely granularly sculptured; antennae of female usually 19 to 22-segmented; of male, normally 21 to 25 segmented; malar space of female at least as long as the first flagellar segment; of male, nearly as long; wings a little dusky on basal half or more; second abscissa of radius only a little or no longer than the first; last abscissa of radius as long as the last abscissa of cubitus, the latter not distinctly twice the preceding abscissa of cubitus; the portion of cubitus between recurrent and first intercubitus fully as long as recurrent; abdomen entirely or nearly entirely sculptured, the second tergite coarsely so; the oblique grooves on first tergite usually foveolate; head, thorax, and abdomen usually mostly testaceous, the thorax often more or less fuscous; legs mostly yellowish-brown.

*Distribution.*—Occurs from Florida to Arizona and north to Illinois and Pennsylvania; also found on the Virgin Islands.

*Hosts.*—*Canarsia hammondi* Riley; *Acrobasis nebulella* Riley; *Mineola indiginella* Zeller; *Mesocondyla gastralis* Guenee; *Enarmonia prunivora* Walsh.

Represented in the National Museum by considerable material from the above-named hosts and from the following localities: Champaign, Illinois; Brownsville, Texas (Bridwell); Tucson, Arizona; Siloam Springs, Arkansas (S. W. Foster); Bentonville, Arkansas (D. Isely); Anderson, Missouri (F. L. Wellman and D. Isely); Kirkwood, Missouri; Thomasville, Georgia; Monticello, Florida (J. B. Gill); and St. Croix, Virgin Islands. Most of this material was reared in the Bureau of Entomology under Quaintance Nos. 5083, 9160, 16459, 16487, 20730.

### 9. MICROBRACON PLATYNOTAE (Cushman)

*Habrobracon platynotae* CUSHMAN, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 104.

*Type.*—Cat. No. 18276, U.S.N.M.

Distinguished from *cushmani* as noted under that species; from *xanthonotus* it differs especially by the characters given in the key; from *gelechiae*, which it very closely resembles in general appearance and in the length of ovipositor, it can be separated by the broader, foveolate suturiform articulation, the presence of a median area on the second tergite set off by short longitudinal furrows, and by the usually more coarsely granular sculpture of the abdomen. Antennae of female usually 22 to 25 segmented, of the male 24 to 27 segmented; first flagellar segment twice as long as thick; head and thorax entirely finely granular; first abscissa of radius usually as long as the second; the part of cubitus between recurrent and intercubitus longer than the recurrent; propodeum without a distinct median carina posteriorly; head and thorax mostly black; abdomen usually testaceous, except at base.

*Distribution.*—Hollywood, California; Durango, Mexico.

*Hosts.*—*Platynota*, species; *Pectinophora gossypiella* Saunders.

In addition to the types the National Museum has a small series of specimens reared from the pink bollworm, at Tlahualilo and Lirdo, Durango, Mexico, by A. C. Johnson and N. B. McKinney.

### 10. MICROBRACON XANTHONOTUS (Ashmead)

Fig. 26

*Bracon xanthonotus* Ashmead, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 618.

*Habrobracon hopkinsi* Viereck, Proc. U. S. Nat. Mus., vol. 38, 1910, p. 380.

*Habrobracon mali* Viereck, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 641.

*Habrobracon xanthonotus* Cushman, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 105.

*Type.*—Cat. No. 14757, U.S.N.M. The types of *hopkinsi* (Cat. No. 12284) and *mali* (Cat. No. 15331) are also in the National Museum.

A thorough study of the types of *xanthonotus*, *hopkinsi*, and *mali* can leave no doubt that all, as Cushman suggested, belong to the same species. The characters upon which they were originally separated are all extremely variable. Some series exhibit practically all intergradations. The head and thorax are finely punctate or minutely granular; the antennae are slender, and in the female normally 23 to 27-segmented, in the male usually 25 to 28-segmented; the first flagellar segment is more than twice as long as thick, in the male nearly three times as long as thick; malar space in female as long as first segment of flagellum, but considerably shorter in the male; second abscissa of radius nearly always a little longer than the first; third abscissa of radius going very nearly to extreme apex of wing and as long as last abscissa of cubitus; the part of cubitus between recurrent and first intercubitus nearly always a little shorter than the recurrent, apparently as long as recurrent in some small males; abdomen usually strongly sculptured, the second tergite and base of third usually longitudinally rugulose; the oblique grooves on first tergite coarsely foveolate, the apex of this tergite commonly rugose; second tergite nearly always with a median basal area set off by longitudinal foveolate furrows; ovipositor sheaths distinctly less than half the length of the abdomen; head and thorax usually black, more or less marked with yellow or red; abdomen varying from mostly testaceous to entirely black; legs varying from mostly blackish to testaceous.

*Distribution.*—California; Washington; Virginia; Minnesota; New Hampshire.

*Hosts.*—*Notolophus oslari* Barnes; *Malacosoma pluvialis* Dyar; *M. constricta* Packard.

The foregoing discussion and characterization are based on the types of *xanthonotus*, *mali*, and *hopkinsi*, and on considerable additional material in the United States National Museum. This material includes series reared from *Malacosoma pluvialis*, at Pullman, Washington, under Washington Experiment Station No. 025; from *M. constricta*, at Sacramento, California, under Bureau of Entomology No. 2747; and from an unknown lepidopterous larva, at Vienna, Virginia, under Quaintance No. 7863 (R. A. Cushman). There are also collected specimens from Santa Cruz Mountains, Yosemite, Summerdale and Alameda, California; Durham, New Hampshire (Weed and Fiske); and St. Anthony Park, Minnesota.

### 11. MICROBRACON HEBETOR (Say)

*Bracon hebetor* Say, Bost. Jour. Nat. Hist., vol. 1, 1836, p. 252.
*Bracon dorsator* Say, Bost. Jour. Nat. Hist., vol. 1, 1836, p. 253.
*Bracon brevicornis* Kirby, Trans. Ent. Soc. Lond., 1884, p. xxxi.—Marshall, Trans. Ent. Soc. Lond., 1885, p. 24, pl. 1, fig. 1a and b.
*Bracon juglandis* Ashmead, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 621.
*Habrobracon hebetor* Johnson, Ent. News, vol. 6, 1895, p. 324.
*Bracon (Habrobracon) honestor* Riley and Howard, Ins. Life, vol. 7, 1895, p. 428. Misprint for *hebetor*, corrected in general index.
*Habrobracon beneficientior* Viereck, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 182.
*Habrobracon brevicornis* Cushman, Proc. Ent. Soc. Wash., vol. 16, 1914, p. 101.—Whiting, Biol. Bull. 34, 1918, p. 350.
*Habrobracon juglandis* Cushman, Proc. Ent. Soc. Wash., vol. 24, 1922, p. 213.

*Type.*—The types of *hebetor* Say and *dorsator* Say have been lost; that of *juglandis* Ashmead and that of *beneficientior* Viereck are in the United States National Museum, the former bearing type catalogue No. 2913, the latter, No. 13494.

This species is exceedingly close to *brevicornis* (Wesmael), and the two have been much confused in literature. Cushman (1922) cleared up this matter, calling attention to the difference in habit in the two species, and pointing out some morphological differences, although he did not regard *juglandis* Ashmead as identical with *hebetor* Say. It appears, after a careful consideration of Say's description of *hebetor*, that there can be no reasonable doubt that Say and Ashmead were dealing with the same species. In fact, Ashmead determined some specimens of this species in the National Museum as *hebetor* Say, although failing to recognize the identity of *juglandis* with this material. The combination of characters ascribed to *hebetor* by Say is found nowhere else in the Braconidae, and after allowing for the wide range of variation occurring in the species, will be found to agree nicely with *juglandis*. *Bracon dorsator* Say is also, without question, this species; and a study of the type of *Habrobracon beneficientior* Viereck shows this species, too, to be identical with *hebetor* Say. References in literature to *Bracon* or *Habrobracon brevicornis*, *hebetor* or *juglandis* as parasites of the Mediterranean flour moth, *Ephestia kuehniella*, of the meal moth, *Plodia interpunctella*, or of the bee-moth, *Galleria mellonella*, concern this species.

The females of *hebetor* are readily distinguished from those of *brevicornis* by the antennae, which are 13 to 15-segmented in the former, and 17 to 19-segmented in the latter. The males of the two species are much more difficult to distinguish, but the characters mentioned in the key will nearly always separate them. The abdomen in *hebetor* is almost invariably somewhat smoother, with the punctures less distinct, than in *brevicornis*. In color this species is exceedingly inconstant.

*Distribution.*—Apparently occurs throughout the world, wherever its hosts, particularly the flour and meal moths, are present.

*Hosts.*—*Ephestia kuehniella* Zeller; *E. elutella* Huebner; *E. cahiritella* Zeller; *Plodia interpunctella* Huebner; *Galleria mellonella* Linnaeus; *Vitula edmansii* Packard; *Sitotroga cerealella* Olivier.

The above discussion is based on abundant reared and collected material in the United States National Museum. Series from the following hosts and localities are contained in this collection; *Ephestia kuehniella*—Reno, Nevada (S. B. Doten); San Francisco, California (G. Compere and W. G. Johnson); *Vitula edmansii* in Bombus nests—Riverton, New Jersey and Champaign, Illinois (T. H. Frison); *Sitotroga cerealella*—Potchefstroom, S. Africa (W. F. Schepp); *Galleria mellonella*—Fillmore, California (J. F. McIntyre); *Plodia interpunctella*—Jamaica Plain, Massachusetts (J. G. Jack); also specimens from cone galls on *Salix longifolia*, Reno, Nevada (G. G. Schweiss); a series from seeds of *Prosopis juliflora*, Cairo, Egypt (H. Morrison); another from a larva infesting soy beans, Mayaguez, Porto Rico (W. A. Mace); 6 specimens labeled "on ship with cocoa beans, O. K. Courtney;" a series reared from infested corn, Santo Domingo, West Indies

(W. V. Tower); 8 specimens from a lepidopterous larva in seeds of *Canarium indicum*, Buitenzorg, Java (L. L. Spessard); 12, labeled "*Grewia cana*, Transvaal, S. Africa;" 2 from St. Petersburg, Russia (J. Schreiner); 1 from Charroux, France (Oberthur); 4 from a seed storehouse, Yates City, Illinois (W. S. Abbott); other specimens from Jacksonville, Florida; Morgantown, West Virginia; Agricultural College, Michigan, and Milton, Massachusetts; and a series of several hundred individuals bred by P. W. Whiting in connection with genetic studies on this species at the University of Pennsylvania.

### 12. MICROBRACON BREVICORNIS (Wesmael)

Fig. 19

*Bracon brevicornis* WESMAEL, Nouv. Mem. Acad. Sci. Bruxelles, vol. 11, 1838, p. 23, fig. 2.—BRISCHKE, Schr. Naturf. Ges. Danzig, ser. 2, vol. 4, 1882, p. 135.

*Habrobracon brevicornis* CUSHMAN, Proc. Ent. Soc. Wash., vol. 24, 1922, p. 122.

*Type.*—Probably in the Brussels Academy of Science.

The similarity of this species to *hebetor* (Say) and the confusion of the two species in literature are discussed under *hebetor*.

*Distribution.*—This species apparently occurs throughout Europe. It has recently been introduced into Massachusetts from France, as a parasite of the imported European Corn-Borer, *Pyrausta nubilalis* Huebner. While it is too early to say whether or not it has become definitely established in the United States, it is included in this paper because of the probability that it will eventually establish itself here.

*Hosts.*—*Dioryctria abietella* Zinck (Brischke); *Pyrausta nubilalis* Huebner.

The following material has been examined: a series of 16 specimens in the National Museum, reared from *Pyrausta nubilalis* at Auch, Gers, France and Hyeres, Var, France, by W. R. Thompson, in the United States Bureau of Entomology, under Webster No. 16490; collected specimens in the National Museum from Saxony and Berlin, Germany, and La Chatre, France; and several hundred specimens bred at the Corn Borer Laboratory of the Bureau of Entomology, at Arlington, Massachusetts, in reproduction work with this species.

### 13. MICROBRACON SCANTICORUM Viereck

*Microbracon scanticorum* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916) pp. 205, 207.

*Type.*—In the Connecticut Agricultural Experiment Station, at New Haven.

The following notes were made on an examination of the type and are given here because the species was originally poorly characterized: Antennae broken at 27th segment, first flagellar segment much longer than the second; malar space shorter than first flagellar segment; transverse diameter of opening between clypeus and mandibles much greater than the distance from the opening to the eyes and about twice the malar space; face minutely sculptured; frons smooth and polished; thorax smooth and polished; parapsidal furrows sparsely hairy; propodeum polished with a stub of a median ridge at apex, and a more or less distinct median roughened groove from the anterior end of this stub to the base of propodeum; propodeum also provided with two lateral oblique foveolate grooves; radius arising distinctly beyond middle of stigma; first abscissa of radius less than one-third the length of the second abscissa and less than half the first intercubitus; radius attaining wing margin much before apex of wing; the portion of cubitus between recurrent and first intercubitus very short, the recurrent very nearly interstitial with first intercubitus; first abdominal tergite finely sculptured apically and laterally; second tergite very minutley granular with a more strongly roughened area medially; following tergites very delicately punctate, the apical tergites very faintly or indistinctly so; suturiform articulation very fine, arcuate, not distinctly foveolate; ovipositor sheaths just about as long as the abdomen. Mostly yellowish; dorsum of thorax more or less blackish; propodeum and first abdominal tergite blackish; wings slightly fuliginous; legs, including all coxae, yellow.

*Distribution.*—West Thompson, Connecticut; Algonquin, Illinois.

*Host.*—Unknown.

Known only from the type, and one additional specimen, a homotype determined by Muesebeck, labeled "Algonquin, Ill. 5-16-96, No. 6603." The latter is in the United States National Museum.

### 14. MICROBRACON PYRALIDIPHAGUS, new species

Resembles *scanticorum* in that the radius arises from beyond the middle of a rather long, narrow, non-angular stigma; in the very short first abscissa of radius, and the rather short radial cell; it differs from that species particularly as noted in the key.

*Female.*—Length, 3.3 mm. Head transverse but rather thick antero-posteriorly at insertion of antennae; face finely granular and opaque; frons smooth and polished; antennae 36-segmented, slightly shorter than the body; first flagellar segment about twice as long as thick; mesonotum and mesopleura smooth and polished; parapsidal grooves sparsely pubescent, more thickly so posteriorly; propodeum finely rugulose over most of its surface and provided with a distinct median longitudinal carina; metapleura finely sculptured; stigma rather narrow, not angular; the radius arising distinctly beyond the middle of stigma; radial cell short, the radius attaining wing margin much before apex of wing; first abscissa of radius short, decidedly less than half the first intercubitus and hardly one-third the second abscissa of radius; posterior femora stout, about three times as long as broad; first abdominal tergite strongly rugulose, the sculpture occurring on the middle of the plate as well as laterally; second tergite about as long as third, granularly rugulose, its posterior margin straight; third tergite granular; the fourth and fifth somewhat granular but less strongly than third; ovipositor sheaths about as long as that part of the dorsum of abdomen beyond second tergite. Reddish brown; head entirely black; mesonotal lobes, metanotum, propodeum and pectus blackish; wings entirely a little fuscous; legs ferruginous, the apex of posterior tibiae and the posterior tarsi dusky; abdomen reddish-brown, the first tergite somewhat infuscated.

*Type.*—Cat. No. 26664, U.S.N.M.

*Type-locality.*—Crowley, Louisiana.

Described from a single specimen labeled "Parasite of *Chilo* and *Diatraea*, Crowley, La., 9–8–23, J. W. Ingram."

### 15. MICROBRACON GASTROIDEAE (Ashmead)

Fig. 1

*Bracon gastroideae* Ashmead, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 617.

*Type.*—Cat. No. 2904, U.S.N.M.

The opening betwen clypeus and mandibles is enormous, its transverse diameter being greater than the length of the face below antennae; female antennae usually 24 to 27-segmented, the basal flagellar segment twice as long as broad, all the following somewhat longer than broad; thorax smooth and polished; parapsidal grooves very sparsely hairy; propodeum with a nearly complete median longitudinal carina, otherwise mostly smooth and polished; first abscissa of radius usually not more than half the first intercubitus and less than half the second abscissa of radius; radial cell rather short, the radius attaining wing margin distinctly before apex of wing; tarsi stout, the posterior tarsi shorter than their tibiae, in the female much shorter; the last segment of posterior tarsi very large, broadening strongly toward apex; much longer than the second segment and more than twice the fourth; in the female at least, and usually in the male, the posterior tibiae three times as long as the metatarsi; abdomen smooth and polished, the second tergite sometimes a little longitudinally sculptured at base; ovipositor sheaths scarcely as long as the first abdominal tergite. Head and thorax black; wings strongly infuscated; coxae black; usually base of femora and more or less of tibiae and tarsi blackish or fuscous; abdomen usually red with first tergite and a median spot on second black, although sometimes abdomen is entirely black.

*Distribution.*—Ohio; Michigan; Illinois; Massachusetts; Canada.

*Host.*—*Gastroidea cyanea* Melsh.

In addition to the type which is from Columbus, Ohio, the National Museum has specimens from Agricultural College, Michigan; Algonquin, Illinois; and Canada (C. F. Baker). There is also a specimen, taken at Arlington, Massachusetts, in the collection of the Corn Borer Laboratory of the Bureau of Entomology at Arlington.

### 16. MICROBRACON BRACHYURUS (Ashmead)

*Bracon brachyurus* ASHMEAD, Can. Ent., vol. 23, 1891, p. 1.

*Type.*—Cat. No. 6853, U.S.N.M.

Very similar to *gastroideae*, with which it agrees in the large opening between clypeus and mandibles, the presence of a median carina on the propodeum, the wing venation, the short posterior tarsi, and the very short ovipositor. It can be readily distinguished, however, by the characters given in the key. The ocelli are exceptionally small, the ocell-ocular line being four times the diameter of an ocellus; the propodeum more or less finely rugulose; head and thorax black; abdomen usually entirely black; posterior coxae black; the two anterior pairs usually yellowish.

*Distribution.*—Ottawa, Canada.

*Host.*—Unknown.

The United States National Museum has, in addition to the type, one other specimen, also from Ottawa, Canada.

### 17. MICROBRACON MELANASPIS (Ashmead)

Fig. 5

*Bracon melanaspis* ASHMEAD, Can. Ent., vol. 23, 1891, p. 1.

*Type.*—Cat. No. 6863, U.S.N.M.

Distinguished especially by the character of the second tergite as described in the key. Frons polished; antennae longer than the body; malar space in the female fully as long as the distance between clypeal foveae; parapsidal grooves rather conspicuously hairy, especially posteriorly; propodeum completely polished without a suggestion of a stub of a median carina at apex; first abscissa of radius about three-fourths the first intercubitus and more than half the second abscissa of radius; posterior legs slender; abdomen completely polished; the chitinized plate of the first tergite slender, parallel-sided; the lateral membranous margins of first tergite broad; second tergite with weakly chitinized areas laterally opposite the membranous margins of the first tergite; the following tergites with the apical margins membranous; suturiform articulation represented by a fine impressed arcuate line, without a suggestion of foveolae; ovipositor sheaths scarcely half as long as the abdomen.

Black; head and thorax black; abdomen black, the membranous parts of the dorsum paler; legs usually blackish.

*Distribution.*—Ottawa, Canada; S. W. Harbor, Maine.

*Host.*—Unknown.

Known only from the type, and one other fine female specimen which is in the Boston Society of Natural History and was taken by C. W. Johnson at S. W. Harbor, Maine, July 13, 1918.

### 18. MICROBRACON JUNCICOLA (Ashmead)

*Bracon juncicola* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 620.
*Microbracon sebequanash* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 204 and 206.

*Type.*—Cat. No. 2911, U.S.N.M. The type of *sebequanash* is in the Connecticut Agricultural Experiment Station at New Haven.

Exceedingly like *melanaspis* in structure, but is probably a distinct species. The few specimens that have been seen differ markedly in color from the type of *melanaspis*, being mostly yellow. Face yellow; thorax and abdomen largely yellow; legs, including all coxae, yellow; malar space about as in *melanaspis;* antennae likewise are similar, being slender and usually 25 to 30-segmented; parapsidal grooves rather strongly pubescent posteriorly; propodeum completely polished with not even an indication of a stub of a median ridge at apex; suturiform articulation exceedingly delicate, merely a fine impressed line; as in *melanaspis*, the apical margins of the tergites beyond the second are usually more or less membranous; ovipositor sheaths hardly half as long as the abdomen.

*Distribution.*—From Missouri to West Virginia and Connecticut.

*Hosts.*—Evidently species of *Coleophora* (Ashmead).

The above notes are based on the types of *juncicola* and *sebequanash;* and on several other specimens in the National Museum from the following localities: Highspire, Pennsylvania; Ohio; West Virginia; Algonquin, Illinois.

### 19. MICROBRACON POLITIVENTRIS (Cushman)

*Habrobracon politiventris* CUSHMAN, Proc. U. S. Nat. Mus., vol. 55, 1919, p. 517.

*Type.*—Cat. No. 21639, U.S.N.M.

Very similar to *pygmaeus*, which it very closely resembles in size, color, habitus, malar space, the sculptured frons and vertex, the pubescence of the parapsidal furrows, the color and venation of the wings, and in other points. It is often difficult to distinguish from that species.

Malar space in the female usually fully as long as the transverse diameter of the opening between clypeus and mandibles; vertex and frons closely punctate and opaque; antennae usually 21 to 25-segmented; thorax stout; parapsidal furrows completely strongly hairy; the surface of the middle lobe of mesoscutum with scattering pubescence anteriorly; propodeum usually faintly minutely reticulate over most of its surface; metapleura with long pubsecence; second abscissa of radius nearly always less than twice the first, and sometimes only half the third; the portion of cubitus between recurrent and first intercubitus usually about half the first intercubitus; abdomen rather broad, smooth and polished; the second tergite usually considerably longer than the third, polished, and provided with two short oblique foveolate furrows medially; ovipositor sheaths not or scarcely half as long as the abdomen. Black; head black, with pale yellow orbital lines; thorax black; wings dusky; coxae black or blackish; femora usually yellow; tibiae and tarsi mostly blackish; abdomen black, usually bright yellow laterally.

*Distribution.*—From Maine to Virginia, and west to Iowa.

*Hosts.*—*Polychrosis viteana* Clemens; *Eulia triferana* Walker; *Archips paralella* Robinson or *Pandemis lamprosana* Robinson. The parasite is gregarious, several individuals developing on a single host.

In addition to the types the collection of the United States National Museum contains two specimens reared from *Eulia triferana*, at Washington, District of Columbia, under Chittenden No. $6099^{02}$; a series reared from a lepidopterous larva on wild cherry, by R. A. Cushman, at Vienna, Virginia, under Quaintance No. 7719; a specimen labeled "Ia. Exp. Sta., Plum curculio"; and one specimen from Hanover, New Hampshire (C. M. Weed). At the Gipsy Moth Laboratory there is a series reared by J. V. Schaffner from a collection of two different species of Tortricidae, *Archips paralella* and *Pandemis lamprosana* taken at Melrose Highlands, Massachusetts; one or the other of these was the host. The collection of the Boston Society of Natural History has a specimen collected at Liberty, Maine, by J. A. Cushman.

### 20. MICROBRACON PYGMAEUS (Provancher)

Figs. 3, 15

*Bracon pygmaeus* PROVANCHER, Natural. Canad., vol. 12, 1880, p. 144.
*Bracon junci* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 619.
*Bracon trifolii* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 622.
*Bracon kansensis* VIERECK, Trans. Kans. Acad. Sci., vol. 19, 1905 (1903–04), p. 268.
*Microbracon coleophorae* ROHWER, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 231.
*Microbracon massasoit* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 205 and 207.

*Type.*—Yellow label 555, Museum of Public Instruction, Parliament Building, Quebec, Canada. The types of *junci* (Cat. No. 2910) *trifolii* (Cat. No. 2916) and *coleophorae* (Cat. No. 18180) are in the United States National Museum; that of *kansensis* is in the Kansas University collection; and that of *massasoit* is in the collection of the State Agricultural Experiment Station, at New Haven, Connecticut.

Very similar to the preceding as pointed out in the discussion under that species; but the characters given in the table to species will serve to distinguish between the two.

Malar space in the female as long as the transverse diameter of the opening between clypeus and mandibles; frons and vertex closely punctate and opaque; antennae usually 24 to 29-segmented; thorax stout; mesoscutum with long and rather thick pubescence along the anterior lateral margins and in the parapsidal grooves; metapleura thickly pubescent; propodeum smooth and shining, not minutely reticulate; second abscissa of radius rarely distinctly twice as long as the first; posterior tibiae and tarsi slender; plate of first abdominal tergite usually a little roughened laterally and across the apex; second tergite usually more or less finely granularly sculptured, without oblique foveolate furrows medially toward base; very rarely third and fourth tergites granular, usually smooth and shining; ovipositor sheaths projecting about half the length of the abdomen. Head black with contrasting yellow inner orbital lines; thorax mostly black, sometimes ferruginous behind the middle lobe of mesoscutum and on the scutellum; wings dusky on basal two-thirds; coxae usually black, although sometimes mostly testaceous; posterior tibiae at apex and their tarsi fuscous; abdomen often mostly reddish testaceous with the first tergite and the apical tergites black, but this is variable, the entire abdomen sometimes being black.

*Distribution.*—Very widely distributed. Occurs from Canada to Florida and westward to California.

*Hosts.*—*Coleophora leucochrysella* Clemens (Rohwer); *C. volckei* Heinrich; and various undetermined species of *Coleophora.*

In addition to the types of *pygmaeus*, *junci*, *trifolii*, *coleophorae*, and *massasoit*, I have seen the following material: In the National Museum, a series reared from *Coleophora volckei* at Washington, District of Columbia, by E. R. Selkregg, under Quaintance No. 7890; another series reared from the same host, at Watsonville, California by W. H. Volck; several specimens from a species of *Coleophora* on *Amaranthus* at Washington, District of Columbia; and collected specimens from Cedar Point, Maryland; Jacksonville, Florida; Algonquin, Illinois; Agricultural College, Maryland; Onaga and Riley Co., Kansas; Vienna, Virginia (R. A. Cushman); Ames, Iowa (C. W. Mally); Indiana; Colorado. The Boston Society of Natural History has one specimen taken by C. W. Johnson at S. W. Harbor, Maine. At the Gipsy Moth Laboratory there is a specimen reared from a species of *Coleophora* taken at Wilmington, Massachusetts. The original description of *kansensis* and notes on the type by A. B. Gahan leave no doubt that this species is *pygmaeus*.

### 21. MICROBRACON CONNECTICUTORUM Viereck

*Microbracon connecticutorum* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 205 and 209.

*Type.*—In the State Agricultural Experiment Station at New Haven, Connecticut.

Resembles *nuperus* and *curtus* in having the head thin antero-posteriorly, in the smooth and polished frons, the completely polished propodeum and the smooth abdomen, but differs especially in the much shorter ovipositor sheaths.

Following are notes made on an examination of the type: Face, frons and vertex smooth and shining; malar space as long as the transverse diameter of the opening between clypeus and mandibles; antennae missing; thorax stout; parapsidal grooves posteriorly, and the metapleura, thickly pubescent; propodeum completely smooth and polished, without a suggestion of a stub of a median ridge at apex; first abscissa of radius nearly as long as the first intercubitus, the second abscissa hardly one and one-half times as long as the first; the portion of cubitus between recurrent vein and first intercubitus nearly as long as the recurrent; abdomen smooth and polished, with a few extremely faint punctures or striae on second tergite; the plate of the first tergite completely polished; ovipositor sheaths not projecting half the length of the abdomen.

*Distribution.*—New Haven, Connecticut.

*Host.*—Unknown.

Known only from the type.

### 22. MICROBRACON PSILOCORSI Viereck

*Microbracon psilocorsi* VIERECK, Proc. U. S. Nat. Mus., vol. 42, 1912, p. 143.

*Type.*—Cat. No. 14317, U.S.N.M.

Resembles *politiventris* in habitus, and in some details, but is easily distinguished. Head thick antero-posteriorly at insertion of antennae; face strongly receding; eyes very short, broad-oval; frons polished; antennae usually 30 to 33-segmented, tapering distinctly toward tip; the ten or twelve basal segments of flagellum more or less subequal; thorax stout, rather thickly pubescent in the parapsidal grooves and on metapleura; scutellum large; radius arising much before middle of stigma and going to extreme apex of wing; second abscissa of radius much more than twice the first; the part of cubitus between recurrent and first intercubitus only half the length of recurrent; measured along cubitus the third cubital cell not distinctly as long as the second; propodeum smooth and polished;

abdomen entirely smooth and polished; second tergite with a basal median area set off by short oblique foveolate furrows, and sometimes with less distinct longitudinal furrows laterally; second tergite about as long as the third; ovipositor sheaths less than half as long as the abdomen. Mostly yellowish; face yellow; frons and vertex sometimes piceous to blackish; mesonotal lobes, lateral faces of scutellum, metathorax, propodeum, and pectus more or less piceous, sometimes thorax mostly blackish except on the pleura; wings infumated on basal two-thirds; legs yellow, the posterior coxae sometimes infuscated; abdomen usually yellowish, with first tergite, and the third and following medially, more or less blackish.

*Distribution.*—Cuero, Texas.

*Host.*—(*Psilocorsis*) *Cryptolechia*, species.

Known only from the type series.

### 23. MICROBRACON MEROMYZAE (Gahan)

*Bracon* (*Tropidobracon*) *meromyzae* GAHAN, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 432.

*Type.*—Cat. No. 16350, U.S.N.M.

Head rather thick antero-posteriorly, not broad; face and frons smooth and polished; antennae slender, usually 28 to 32-segmented, as long as the body in the female, longer in the male; thorax slender, polished; parapsidal grooves sparsely hairy; propodeum polished, usually with a nearly complete median longitudinal carina; radius going practically to extreme apex of wing; second abscissa of radius twice as long as the first; the chitinized plate of first tergite slender, rugose laterally and at apex; second and third tergites finely granular, shining; rarely the fourth tergite faintly granular in part; remainder of dorsum of abdomen smooth and polished; ovipositor sheaths less than half the length of abdomen. Head wholly black; thorax black, pectus sometimes more or less yellowish; wings very slightly dusky; legs, including all coxae, bright yellow; abdomen more or less blackish above, second and third tergites mostly yellow.

*Distribution.*—South Dakota.

*Host.*—*Meromyza americana* Fitch.

Known only from the types, and two additional specimens, from Brookings, South Dakota, in the United States National Museum.

### 24. MICROBRACON NIGRIDORSUM (Ashmead)

*Bracon nigridorsum* ASHMEAD, Can. Ent., vol. 23, 1891, p. 2.

*Type.*—Cat. No. 6862, U.S.N.M.

Head rather thick antero-posteriorly, the face strongly receding; temples broad; eyes short, broad-oval; face and frons smooth and polished; antennae slender, 35-segmented in the type, the first flagellar segment twice as long as broad, all the following one and one-half times as long as broad, thorax stout, smooth and polished; parapsidal grooves sparsely hairy; propodeum smooth and polished; first abdominal tergite somewhat roughened laterally and at apex; second tergite with a little very faint sculpture medially; suturiform articulation very fine; third and following tergites completely smooth and polished; ovipostor sheaths projecting hardly half the length of the abdomen. Head black, with very narrow ferruginous inner and superior orbital lines; thorax black; wings hyaline; legs, including all coxae, bright yellow; abdomen in type honey-yellow, with first tergite and transverse median spots on second, third and fourth tergites, black.

*Distribution.*—Ottawa, Canada.

*Host.*—Unknown.

The type is the only specimen known to me.

### 25. MICROBRACON ASHMEADI, new name

*Macrodyctium politum* Ashmead, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 252; [not (*Bracon politus* Provancher)=*Microbracon nuperus* (Cresson).]

*Type.*—Cat. No. 5712, U.S.N.M.

Head not thin antero-posteriorly, face receding; eyes broad; face and frons smooth and polished; opening between clypeus and mandibles small, its transverse diameter not greater than the distance from the opening to the eye; thorax long and slender, fully twice as long as its greatest depth; parapsidal grooves sparsely hairy; metanotum longer than usual; propodeum long, with a stub of a median carina at apex and a few short ridges diverging from this; stigma large, long; both second and third cubital cells long; last abscissa of radius longer than first and second abscissae combined; posterior tarsi rather stout, the apical tarsal segment large and fully as long as the second; abdomen long and narrow; first tergite slender, broadening gradually toward apex, and a little rugulose laterally and at apex; second tergite with faint striae medially; suturiform articulation very delicate; remainder of tergum polished; hypopygium not attaining apex of last dorsal segment; ovipositor sheaths less than half as long as the abdomen. Head, thorax and abdomen entirely black; wings a little infuscated; legs, including coxae, black; tibiae yellow on the basal half.

*Distribution.*—Alaska.

*Host.*—Unknown.

Known only from the unique type.

### 26. MICROBRACON UNCAS Viereck

*Microbracon uncas* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 206 and 208.

*Type.*—In the State Agricultural Experiment Station, at New Haven, Connecticut.

Exceedingly similar to *ashmeadi*, agreeing in habitus, in the small size of the opening between clypeus and mandibles, in the smooth frons, in the form, sculpture and pubescence of thorax; in the venation of the wings; in the stout tarsi and large last tarsal segment; in size, shape and sculpture of the abdomen; in the hypopygium not attaining apex of last dorsal abdominal segment; the length of the ovipositor sheaths, and the general color. Appears to differ only in the color of the legs, which are yellow, with the posterior coxae a little blackish at extreme base. The propodeum has, in addition to the apical median carina, a slight median longitudinal elevation and adjoining fine sculpture at base.

*Distribution.*—New Haven, Connecticut.

*Host.*—Unknown.

Known only from the type.

### 27. MICROBRACON ANGELESIUS (Provancher)

*Bracon angelesius* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 372.
*Bracon cecidomyiae* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 616.
*Bracon euurae* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 621.

*Type.*—Yellow label 1486, Museum of Public Instruction, at Quebec, Canada; the head is broken off, but is mounted on one of the labels. The types of *cecidomyiae* (Cat. No. 2903) and *euurae* (Cat. No. 2914) are in the United States National Museum.

Distinguished especially by the very slender antennae, the long ovipositor, the entirely polished abdomen, hyaline wings, and color of the body. Head rather thick antero-posteriorly; face receding rather strongly; antennae of the type, and those of the type of *euurae*, are broken at or beyond the middle; the type of *cecidomyiae* has 32-segmented antennae; in all three the first flagellar segment is nearly three times as long as broad, and all the following segments are fully twice as long as broad; frons polished; thorax polished; parapsidal grooves very sparsely hairy anteriorly, more closely hairy behind; propodeum smooth and polished, with a short stub of a median carina at apex; anterior wings of type are missing; in the types of *euurae* and *cecidomyiae* the radial cell is large and long, and the second abscissa of radius is not distinctly twice as long as the first; posterior femora slender; abdomen completely smooth and polished; ovipositor sheaths one and one-half times as long as the abdomen. Face yellow; vertex and occiput more or less piceous; thorax yellow, the pectus and the propodeum usually fuscous or blackish; wings perfectly clear hyaline; legs, including all coxae, bright yellow, the posterior tibiae at apex and their tarsi more or less infuscated; abdomen yellow or yellowish-ferruginous with transverse fuscous or blackish bands on the second, third, and fourth tergites.

*Distribution.*—California.

*Hosts.*—Euura, species, which forms galls on *Salix;* and a cecidomyid gall on *Mimulus.*

Known only from the types of *angelesius*, *cecidomyiae*, and *euurae.* A thorough study of the three types clearly shows them to be conspecific.

### 28. MICROBRACON AURIPES (Provancher)

*Bracon auripes* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 372.

*Type.*—Blue label 670, yellow label 1571, Museum of Public Instruction, at Quebec, Canada.

Following are notes made upon an examination of the type: Head missing; thorax slender, smooth and polished; radius going practically to extreme apex of wing; second abscissa of radius more than twice the first, the third longer than first and second combined; recurrent vein more than twice as long as the portion of cubitus between recurrent and first intercubitus; first abdominal tergite slender, broadening gradually toward apex, with a finely foveolate groove just inside the lateral margins; second tergite longer than third, finely ruguloso-striate; suturiform articulation very fine; remainder of abdomen highly polished; ovipositor sheaths very nearly as long as the abdomen. Thorax black with a large testaceous spot behind middle lobe of mesoscutum, and with the propleura testaceous; wings hyaline; legs, including all coxae, wholly yellow; abdomen black above, with narrow yellow lateral margins and with a bright yellow spot at the apex; venter mostly yellowish. A homotype and other specimens in the same series show the species to have a black, smooth and polished, evenly rounded head, with very slender antennae, which have all the flagellar segments more than twice as long as thick, and are 27 to 32-segmented. The thorax is sometimes entirely black.

*Distribution.*—Ottawa, Canada; Massachusetts.

*Hosts.*—Lepidopterous larvae boring in various weeds, such as *Amaranthus*, *Ambrosia*, *Xanthium*, etc.

In addition to the type, I have seen a large series of specimens reared from such plants as indicated above, at the Corn Borer Laboratory of the Bureau of Entomology, at Arlington, Massachusetts.

This material is from Watertown, Malden, Melrose, Stoneham, Saugus, and Wakefield, Massachusetts. One of these specimens was compared with the type, designated a homotype, and placed in the United States National Museum.

### 29. MICROBRACON RUDBECKIAE, new species

Figs. 2, 22

*Female.*—Length, 3.3 mm. Head rather thin, not prominent at insertion of antennae, the face rather flat, not, or very slightly, receding; eyes small; ocelli small; ocell-ocular line more three times the diameter of an ocellus; postocellar line about twice the diameter of an ocellus; opening between clypeus and mandibles large, its transverse diameter nearly twice the length of malar space; face, frons, vertex, temples, smooth and polished; antennae 24-segmented, shorter than the body, basal flagellar segments the longest; thorax stout, smooth, and polished; the parapsidal grooves sparsely hairy; propodeum entirely polished, without even a suggestion of a stub of a carina at apex; second abscissa of radius usually distinctly less than twice the first; the third longer than the first and second combined and usually about twice as long as the second, which is but little longer than the first intercubitus; the portion of cubitus between recurrent and first intercubitus more than half as long as the recurrent; the last abscissa of cubitus considerably longer than the preceding abscissa; legs slender; last segment of posterior tarsi not as long as the second; abdomen a little longer than the thorax; the chitinized plate of the first tergite nearly parallel-sided, angled at the spiracles, smooth and polished, with two fine curved grooves converging toward the base; second tergite transverse, with conspicuous membranous areas laterally opposite the membranous margins along the first tergite, and with a slight tubercle at base and adjoining fine striae; third and following tergites smooth and polished; ovipositor sheaths distinctly longer than the entire body. Yellow; vertex of head and occiput more or less piceous; mesonotal lobes and propodeum sometimes a little dusky; wings distinctly infuscated on basal two-thirds, nearly hyaline at apex; legs including all coxae yellow, the tibiae usually slightly dusky.

*Male.*—Antennae 26-segmented. Essentially as in the female.

*Type.*—Cat. No. 26662, U.S.N.M.

*Type-locality.*—Mineral Wells, Texas.

*Host.*—A larva living in the head of *Rudbeckia amplex.*

Described from 20 female and 2 male specimens reared by C. R. Jones. The number of segments in the antennae in this series varies from 23 to 26.

### 30. MICROBRACON TENUICEPS, new species

Fig. 7

Very similar in structure to *rudbeckiae*, but is almost completely black, has the second abdominal tergite wholly smooth and polished, and differs in numerous details; also resembles *nuperus*, but differs as noted in the key.

*Female.*—Length, 3 mm. Head thin antero-posteriorly, scarcely thicker at insertion of antennae than at the clypeus, the face not or hardly receding; the frons almost vertical; face, frons, vertex, and temples smooth and polished; eyes nearly twice as long as broad, faintly hairy; transverse diameter of opening between clypeus and mandibles not twice the length of the malar space; post-ocellar line not distinctly twice, the ocell-ocular line not distinctly three times, as long as the diameter of an ocellus; antennae 23-segmented, the basal flagellar segment nearly three times as long as broad, the following gradually decreasing in length, but most of them fully twice as long as broad; thorax rather stout, completely smooth and polished; parapsidal furrows sparsely hairy anteriorly, more thickly so posteriorly; propodeum entirely polished, without even a stub of a median longitudinal ridge at apex; first abscissa of radius longer than the recurrent vein; second abscissa of radius much less than twice the first, only half the third, and but very slightly longer than the first intercubitus; radius attaining wing margin distinctly before the apex; last abscissa of cubitus a little longer than the preceding abscissa; legs slender, the posterior femora at least four-fifths as long as their tibiae; abdomen about as long as the thorax, completely smooth and highly polished; the chitinized plate of first tergite broad, and with two fine impressed curved lines converging toward base; second abdominal tergite with a small but conspicuous, more or less triangular, membranous area at either side joining the lateral membranous margins of the first tergite; second tergite much shorter than the third; hypopygium attaining apex of last dorsal abdominal segment; ovipositor sheaths fully as long as the entire body. Black; head and thorax wholly black; wings strongly infuscated; legs deep black, except the anterior femora at apex, their tibiae within, and the middle and posterior tibiae at extreme base, where they are brownish; abdomen black except the membranous margins along first tergite, the membranous areas in the basal lateral angles of the second, and a very small spot in the basal lateral angles of the third, which are bright yellow, contrasting strongly with the deep black of the remainder of the abdomen.

*Type.*—Cat. No. 27142, U.S.N.M.

*Type-locality.*—Chester, Virginia.

*Host.*—? *Phytonomus nigrirostris* Fabricius.

Described from a fine single specimen taken by W. J. Schoene in connection with studies of the clover weevil, *Phytonomus nigrirostris*. C. W. Johnson, of the Boston Society of Natural History, has several fine specimens of this striking species, which were collected by him at Bar Harbor, Southwest Harbor, Salisbury Cove, and Mount Desert, Maine; one small female in this collection has only 18 segments in the antennae.

### 31. MICROBRACON NUPERUS (Cresson)

*Bracon nuperus* CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 187, line 20.
*Bracon minimus* CRESSON, Trans. Amer, Ent. Soc., vol. 4, 1872, p. 187, line 31.
*Bracon politus* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 373.
*Microbracon (Bracon) nuperus* PIERCE, U. S. D. A., Bur. Ent. Bull. 63, 1909, p. 44.

*Type.*—No. 1686, Philadelphia Academy of Sciences, Philadelphia, Pennsylvania. The types of *minimus* (Cat. No. 1613, allotype; holotype lost) and *politus* (Cat. No. 1969) are in the United States National Museum. The allotype of *vernoniae* Ashmead, which also belongs here, is likewise in the National Museum.

Resembles *tenuiceps* in the general conformation of the head, in the polished frons, completely polished propodeum, in the dusky wings and the long ovipositor, but can be readily separated. It is very closely allied to *curtus*, and some males can probably be distinguished only with great difficulty; the female differs in the longer ovipositor.

Head thin, the face but slightly receding; eyes shorter than in *tenuiceps;* transverse diameter of the opening between clypeus and mandibles not distinctly one and one-half times the length of the malar space in either sex; ocell-ocular line at least three times the diameter of an ocellus; antennae usually 21 to 30 segmented, the number varying with the size of the insect; thorax, with propodeum, entirely highly polished; second abscissa of radius about twice the first; the third longer than the first and second combined; radius attaining wing margin before the apex; last abscissa of cubitus longer than the preceding abscissa; plate of first abdominal tergite rather broad posteriorly, smooth and polished, sometimes more or less punctate along apical margin; second tergite usually with a polished elevation medially at base, and more or less rugulose on the basal two-thirds; suturiform articulation usually slightly arcuate medially and finely foveolate; second tergite as long as the third; third and following completely polished; ovipositor sheaths as long as the body. Head black, rarely with poorly defined ferruginous inner orbital markings; thorax wholly black, although rarely with some ferruginous or testaceous markings; wings strongly infuscated on basal two-thirds, more hyaline at apex; legs, at least the coxae, nearly always black; rarely the coxae mostly ferruginous or testaceous; femora sometimes testaceous or yellowish-brown, although frequently mostly black; abdomen varying from entirely ferruginous or testaceous, except at extreme base, to entirely black except more or less of second and third tergites.

*Distribution.*—From Montana to Mexico, and from Illinois to California; apparently more common over the western half of the United States.

*Hosts.*—? *Orthoris crotchii* LeConte; larva feeding in seed capsules of *Vernonia.*

In addition to the types, the following material, all of it in the National Museum, has been examined; the allotype of *vernoniae* Ashmead, which is certainly *nuperus;* two specimens labeled "parasite on dipteron in seeds of *Vernonia*, Kirkwood, Missouri, M. E. Murtfeldt;" one female bearing Bureau of Entomology No. 3557°, and dated May 18, 1885, which are the same data found on the labels of the allotype of *vernoniae;* one specimen labeled "Pullman, Washington, C. V. Piper, Wash. Exp. Sta. No. 010;" and collected specimens from Helena, Montana; Las Cruces, New Mexico (Cockerell); Texas (Belfrage); Alameda Co., California; Forest Grove, Oregon (L. P. Rockwood); "40 miles north of Lusk, Wyoming;" Torreon Coahuilo, Mexico; Algonquin, Illinois. There is one specimen at the Gipsy Moth Laboratory of the Bureau of Entomology from Fresno, California (M. E. Phillips). Pierce records the species as having been reared in very large numbers from *Orthoris crotchii*, feeding in the seed pods of *Mentzelia nuda* at Clarendon, Texas.

### 32. MICROBRACON CURTUS (Provancher)

*Phylax curtus* PROVANCHER, Addit. faun. Canad. Hymen., 1886, p. 130.
*Zele curtus* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 380.

*Type.*—Blue label 277, yellow label 1276, Museum of Public Instruction, Quebec, Canada.

Head thin antero-posteriorly, the face scarcely receding; malar space, in female, about as long as first flagellar segment; face and frons smooth and polished; antennae of type 25-segmented, none of the flagellar segments twice as long as thick; thorax stout, smooth and polished; propodeum completely polished, without even a stub of a median ridge at apex; radius arising before middle of stigma; second abscissa of radius scarcely twice the first; last abscissa of cubitus not distinctly longer than the preceding abscissa; abdomen broad-oval, entirely smooth and polished, with no suggestion of sculpture on the second tergite, in which respect this species appears to differ from *nuperus;* ovipositor sheaths slightly longer than the abdomen. Head and thorax mostly brownish-black to black; wings strongly infuscated on basal two-thirds; legs, including coxae testaceous to reddish-brown; abdomen mostly testaceous to ferruginous.

*Distribution.*—Ottawa, Canada.

*Host.*—Unknown.

The foregoing notes are based on the type, and a homotype (determined by Rohwer); the latter is in the United States National Museum; it bears no locality data.

### 33. MICROBRACON HYSLOPI Viereck

*Microbracon hyslopi* VIERECK, Proc. U. S. Nat. Mus., vol. 42, 1912, p. 143.

*Type.*—Cat. No. 14316, U.S.N.M.

Head not very prominent at insertion of antennae; face slightly receding; malar space in female about as long as first segment of antennal flagellum; the transverse diameter of the opening between clypeus and mandibles but little greater than the distance from this opening to the eye; face very faintly punctate; frons weakly punctate just above insertion of antennae; antennae usually 30 to 40 segmented; the two basal flagellar segments of equal length, all flagellar segments considerably longer than broad, but none of them distinctly twice as long as broad; ocell-ocular line three times as long as the diameter of an ocellus; thorax stout, smooth and polished; propodeum with a distinct stub of a median ridge at apex; radius not attaining apex of wing, second abscissa of radius about twice as long as the first, the third about as long as the first and second combined; the portion of cubitus between recurrent and first intercubitus more than half as long as recurrent; abdomen robust, mostly smooth and polished; first tergite rugulose along posterior margin; second tergite more or less rugulose or granular; third tergite rarely faintly punctate; ovipositor sheaths fully as long as the abdomen. Head black, sometimes with ferruginous or testaceous inner and superior orbital markings; cheeks and temples sometimes testaceous; thorax with mesoscutum and scutellum and more or less of the pleura usually testaceous; propodeum and pectus black; rarely thorax almost wholly black; wings rather strongly infuscated, the stigma, at least at base and along costal margin bright yellow; all coxae and trochanters, and usually most of the middle and hind femora, tibiae and tarsi, black; abdomen usually mostly testaceous, with black median areas on most of the tergites.

*Distribution.*—Washington, Oregon, Utah, Colorado.

*Host.*—*Etiella zinckenella schisticolor* Zeller.

In addition to the type the United States National Museum has three specimens reared from a lepidopteron on *Trifolium* at Manzanita, Oregon, by L. P. Rockwood, and one specimen from Colorado. At the Gipsy Moth Laboratory there are two specimens from Salt Lake City.

### 34. MICROBRACON NITIDUS (Provancher)

*Bracon nitidus* PROVANCHER, Natural. Canad., vol. 14, 1883, p. 15.

*Type.*—Yellow label 1026, Museum of Public Instruction, at Quebec, Canada.

The following notes were made upon an examination of the tpye: Frons polished; antennae 28-segmented, stout, the flagellar segments beyond second only a little longer than broad; transverse diameter of opening between clypeus and mandibles but very little greater than the distance from the opening to the eyes; malar space as long as or longer than the first segment of antennal flagellum; thorax nearly twice as long as its greatest height, smooth and polished; propodeum mostly smooth and polished, with a median longitudinal carina extending from the apex half way to the base, and finely sculptured along the median line between the end of this carina and the base, usually also with a little faint sculpture either side of the median line on the basal half; second abscissa of radius a little more than twice as long as the first; the third abscissa slightly longer than the first and second abscissae combined; first abdominal tergite broad posteriorly, finely rugulose laterally and a little punctate along the apical margin; second tergite slightly rugulose over a small basal middle area, very faintly punctate over most of the remainder of its surface, strongly shining, third and following tergites smooth and polished; ovipositor sheaths about as long as the abdomen. Head blackish; face brownish-black; thorax black; wings a little dusky; legs reddish-yellow, the coxae black or blackish; abdomen black, the second and third tergites mostly yellowish-ferruginous; apical margin of third tergite black; base of fourth tergite reddish.

*Distribution.*—Canada; Maine.

*Host.*—Unknown.

In addition to the type, I have seen a female specimen taken by C. W. Johnson at Fort Kent, Maine, August 19, 1910, which, following comparison with the type, I designated a homotype. This specimen is in the collection of the Boston Society of Natural History. It differs from the type only in having 25 instead of 28 segments in the antennae, and in having the parts that are testaceous in the type, reddish or reddish-brown. Mr. Johnson has taken two other female specimens of this species, at Southwest Harbor and Mount Desert, Maine, respectively. He has very kindly presented one of these to the National Museum.

### 35. MICROBRACON TYCHII, new species

Fig. 21

Somewhat resembles *hyslopi*, but can be readily distinguished by the characters given in the key.

Length 3.8 mm. Head rather thick antero-posteriorly at insertion of antennae; face strongly receding below; temples broad; transverse diameter of opening between clypeus and mandibles but very little greater than the distance from the opening to the eyes; malar space as long as first segment of antennal flagellum, or very nearly; antennae shorter than the body, 28-segmented, tapering slightly toward tip, the basal flagellar segment about twice as long as broad, all the following considerably longer than broad; postocellar line about twice, ocell-ocular line three times, as long as the diameter of an ocellus; face very faintly punctate and clothed with long hairs; frons smooth and polished; thorax rather robust, although about twice as long as high, smooth and polished; parapsidal furrows with scattered long hairs; propodeum smooth and polished without a distinct median longitudinal carina posteriorly, but sometimes with a faint stub of a median ridge at apex; metapleura, propodeum laterally, and the posterior coxae clothed with long silken hairs; second abscissa of radius usually decidedly less than twice the first; the latter about as long as the side of stigma bordering the first cubital cell; the third abscissa of radius longer than the first and second abscissae combined; abdomen fully as long as the thorax; plate of first tergite more or less sculptured laterally and posteriorly; second tergite transverse, about as long as the third, with a low polished tubercle at base in the middle, and the integument immediately adjoining the tubercle more or less finely sculptured; the second tergite laterally and posteriorly, and the third and following tergites entirely, smooth and polished; suturiform articulation fine, smooth, not at all foveolate; ovipositor sheaths about as long as the abdomen or slightly shorter. Black; head entirely black; thorax black, the scutellum usually yellowish or ferruginous at apex and along its sides, and sometimes poorly defined pale markings on the mesopleura and pectus; wings dusky toward base, more hyaline apically; all coxae and trochanters, and more or less of the femora basally, black; the tibiae and tarsi more or less blackish or fuscous; abdomen black except along the lateral margins.

*Male.*—Essentially as in the female. The antennae are 30-segmented; the malar space is a little shorter and the opening between clypeus and mandibles a little larger, than in the opposite sex.

*Type.*—Cat. No. 26669, U.S.N.M.

*Type-locality.*—Los Angeles County, California.

*Host.*—*Tychius semisquamosus* LeConte.

Described from 24 specimens reared in May and June, 1892, by D. W. Coquillet.

### 36. MICROBRACON PINI, new species

Fig. 14

Closely resembles *tychii*, but differs in the somewhat shorter malar space, the larger opening between clypeus and mandibles, in the presence of a distinct sharp stub of a median longitudinal ridge at the apex of propodeum; in the first abscissa of radius being shorter than the inner side of stigma, and in the legs being usually less black.

*Female.*—Length, 3 mm. Head much thicker antero-posteriorly at insertion of antennae than at the lower margin of clypeus; transverse diameter of opening between clypeus and mandibles greater than the distance from the opening to the eyes, malar space much shorter than the first segment of antennal flagellum; temples not as broad as in the preceding species, postocellar line scarcely one and one-half times, ocell-ocular line less than three times, the diameter of an ocellus; antennae 31-segmented, the first flagellar segment about twice as long as broad, all the following considerably longer than broad; face and frons polished; thorax smooth and polished, parapsidal furrows sparsely hairy; propodeum polished, with a distinct stub of a median longitudinal ridge at apex; second abscissa of radius decidedly less than twice the first; the third abscissa longer than the first and second abscissae combined; last abscissa of cubitus much longer than the preceding abscissa; the portion of cubitus between recurrent and first intercubitus much more than half as long as the recurrent; abdomen long-oval; plate of first tergite more or less sculptured laterally and apically; second tergite reguloso-striate medially, smooth and shining laterally; third and following tergites smooth and polished; rarely the third faintly sculptured; ovipositor sheaths about as long as the abdomen beyond first tergite. Black; head and thorax wholly black; wings very slightly dusky; coxae usually mostly black or blackish, remainder of legs brownish with more or less infuscation; abdomen black; second tergite usually yellowish-brown except medially where it is black; third tergite usually somewhat yellowish along basal margin and laterally.

*Male.*—Agrees with the female except for the usual sexual differences. Antennae 33-segmented, the flagellar segments a little more slender than in the female.

*Type.*—Cat. No. 27143, U.S.N.M.

*Type-locality.*—Gardner, Massachusetts.

*Allotype-locality.*—Saugus, Massachusetts.

*Host.*—*Pissodes strobi* Peck.

Described from 8 female and 4 male specimens reared at the Gipsy Moth Laboratory, Melrose Highlands, Massachusetts, from the above-named host, by J. V. Schaffner under Gipsy Moth Laboratory Nos. 12164 H 1–a, and 12164 H 1–b. There are several additional specimens in the United States National Museum, reared from *Pissodes strobi* taken at Rainbow, Windsor, and Portland, Connecticut, by S. N. Spring, B. H. Walden and M. P. Zappe.

### 37. MICROBRACON SESIAE, new species

Figs. 8, 9

Very similar to *nevadensis*, but distinguished as noted in the table to species.

*Female.*—Length, 4 mm. Head thick at insertion of antennae; face short, receding below; transverse diameter of the opening between clypeus and mandibles considerably greater than the shortest distance from the opening to the eyes, and nearly as long as the distance from lower margin of antennal foramina to the clypeus; malar space shorter than first segment of antennal flagellum; eyes broad, very sparsely hairy; ocell-ocular line about three times as long as the diameter of an ocellus; face finely punctate; frons very faintly punctate just above antennae; antennae 32-segmented in type, stout, most of the flagellar segments only a little longer than broad; thorax stout, smooth and polished; parapsidal grooves very sparsely hairy; propodeum smooth and polished, with a short stub of a median longitudinal ridge at apex and a few short lateral ridges diverging from this; posterior tibiae and tarsi long, the third segment of tarsi about as long as the fifth, the second much longer; radius attaining wing margin distinctly before the apex; second abscissa of radius twice as long as the first; the third fully as long as the first and second combined and as long as the last abscissa of cubitus; the latter is distinctly longer than the preceding abscissa of cubitus, the third cubital cell being longer, measured along the cubitus, than the second; abdomen long-oval; the chitinized plate of the first tergite sculptured laterally and along the apical margin; second tergite usually mostly finely longitudinally striate with a more or less triangular median embossed area, which is broadest at the base of the tergite; third tergite nearly always finely striate toward base; remainder of dorsum of abdomen smooth and polished; ovipositor sheaths about as long as the abdomen. Head black, usually with poorly defined ferruginous orbital markings; thorax black, usually somewhat marked with ferruginous, especially in the parapsidal furrows and on the propleura; wings dusky, weakly so toward apex; coxae and trochanters black or blackish; the femora varying from entirely ferrugino-testaceous to almost entirely black; even in specimens having the posterior femora wholly ferruginous the hind tibiae are entirely black except at extreme base and their tarsi are black; abdomen mostly yellowish ferruginous, with the first tergite and the embossed area on second black; sometimes apex of abdomen is more or less blackish.

*Male.*—Agrees with the female in all essential characters. The antennae of allotype are 34-segmented.

*Type.*—Cat. No. 26663, U.S.N.M.

*Type-locality.*—Wallingford, Connecticut.

*Host.*—(*Sesia*) *Aegeria tipuliformis* Linnaeus.

Described from 7 female and 8 male specimens reared by B. A. Porter in the Bureau of Entomology. In this series the number of segments in the antennae varies from 32 to 37.

### 38. MICROBRACON NEVADENSIS (Ashmead)

*Bracon nevadensis* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 623.

*Type.*—Cat. No. 2916, U.S.N.M.

Exceedingly similar to *sesiae;* but the antennal segments are even stouter than in that species; the radial cell is shorter; the last abscissa of radius is distinctly shorter than the last abscissa of cubitus; and the duskiness of the posterior tibiae is confined to the apical third. The antennae are very stout, most of the flagellar segments being not longer than broad and some of them being broader than long; opening between clypeus and mandibles large; the thorax is not quite so deep as in *sesiae*, being twice as long as its greatest height; in the sculpture of the abdomen and the color of the body the two species agree almost exactly; the difference in the color of the tibiae noted above appears to be constant; the ovipositor sheaths are about as long as the abdomen.

*Distribution.*—California; Idaho.

In addition to the type, the United States National Museum has four specimens recorded as a parasite of *Chrysobothris deleta* LeConte on strawberry, at Coeur d'Alene, Idaho, under Bureau of Entomology No. 4765$^{02}$.

### 39. MICROBRACON THURBERIPHAGAE, new species

*Microbracon*, new species, WEBB, Journ. Econ. Ent., vol. 16, 1923, p. 545.

*Female.*—Length, 2.5 mm.; head rather thick at insertion of antennae; face strongly receding below; malar space much shorter than first segment of antennal flagellum and only a little more than half the transverse diameter of the opening between clypeus and mandibles; postocellar line one and one-half times, ocellocular line less than three times, as long as the diameter of an ocellus; antennae 23 segmented in the type, shorter than the body, all the flagellar segments considerably longer than broad, the first twice as long as broad; eyes very short-oval, only a little longer than broad; face faintly punctate, shining; frons closely minutely punctate or reticulate; thorax compact, smooth and polished; scutellum large, the furrow between it and the mesoscutum very fine, minutely foveolate; propodeum polished, with a short stub of a median longitudinal ridge at apex; radius arising much before the middle of the long stigma and going to extreme apex of wing; second abscissa of radius twice, or nearly, as long as the first, the third about as long as the first and second combined; abdomen short oval; the chitinized plate of the first tergite broad posteriorly, more or less rugulose laterally and faintly sculptured along apical margin; second tergite emarginate medially behind, mostly smooth, shining, with a small basal median embossed area set off by short impressions, and usually with two longitudinal furrows laterally, suturiform articulation arcuate and finely foveolate; third, fourth, and fifth tergites evenly granular; ovipositor sheaths a little longer than the abdomen. Yellow; antennae and stemmaticum black; occiput blackish; wings very slightly dusky; legs yellow, the posterior tibiae at apex and their tarsi dusky; abdomen entirely yellow.

*Male.*—Agrees with the female except for the usual sexual differences; antennae 23-segmented; the mesonotal lobes, the propodeum, and the posterior coxae are somewhat infuscated.

*Type.*—Cat. No. 26667, U.S.N.M.

*Type-locality.*—Sabino Canyon, Arizona.

*Host.*—*Thurberiphaga diffusa* Barnes.

Described from two female and five male specimens reared by C. H. T. Townsend, October 2, 1918. The thorax and abdomen are sometimes more or less marked with black, and the middle and posterior coxae, at least of the males, are sometimes black. The number of segments in the antennae varies, in this series, from 21 to 23.

### 40. MICROBRACON PITYOPHTHORI, new species

*Female.*—Length, 2.3 mm. Head much thicker at insertion of antennae than at the clypeus, the face strongly receding; malar space nearly as long as the transverse diameter of the opening between clypeus and mandibles, but much shorter than the first segment of antennal flagellum; eyes short oval, hardly one and one-half times as long as broad; ocelli small; postocellar line about one and one-half times, ocell-ocular line three times, as long as the diameter of an ocellus; antennae very slender, slightly shorter than the body, 23-segmented; the first flagellar segment three times as long as thick, all the following at least twice as long as thick; face very faintly punctate, shining; frons minutely reticulately punctate; thorax robust, smooth and polished; parapsidal grooves very sparsely hairy anteriorly, more closely so posteriorly; propodeum smooth and polished with an exceedingly short stub of a median ridge at apex; stigma very long; veins slender; radius arising much before middle of stigma and going to extreme apex of wing; first abscissa of radius long; second abscissa hardly twice the first; the third as long as the first and second combined; abdomen broad-oval; chitinized plate of first tergite finely rugulose apically; second tergite delicately ruguloso-striate, with a more or less distinct fine median raised line down the middle; suturiform articulation slightly arcuate medially ,and curving forward strongly at the sides, weakly foveolate; third and fourth tergites finely granular, smooth laterally, the fourth with a fine impressed transverse line at the base; fifth tergite very faintly punctate, strongly shining; ovipositor sheaths as long as the dorsum of abdomen beyond first tergite. Head piceous, the face yellowish ferruginous; thorax dark reddish brown; legs, including all coxae, yellow; wings perfectly clear hyaline; abdomen yellowish ferruginous.

*Type.*—Cat. No. 27144, U.S.N.M.

*Type-locality.*—Las Vegas, New Mexico.

*Host.*—*Pityophthorus*, species.

Described from two female specimens reared by Barber and Schwarz from the above host, which was infesting twigs of *Pinus edulis.*

### 41. MICROBRACON LAEMOSACCI, new species

Closely related to the preceding species, as indicated in the key, but differing especially in the characters there noted.

*Female.*—Length, 3 mm.; head thick antero-posteriorly at insertion of antennae; face receding; transverse diameter of opening between clypeus and mandibles fully twice as long as the malar space, and much longer than the distance from the opening to the eyes; eyes broad-oval; postocellar line slightly longer than the diameter of an ocellus; ocell-ocular line twice the diameter of an ocellus; antennae slender, a little shorter than the body, 27-segmented; the first and second flagellar segments nearly three times as long as thick, all the following at least twice as long as thick; thorax compact, smooth, and polished; parapsidal grooves thickly hairy anteriorly as well as posteriorly; propodeum polished, with a short stub of a median longitudinal ridge at apex; stigma long; radius arising much before middle of stigma and going practically to the apex of wing; first abscissa of radius longer than the recurrent; the second not or hardly twice as long as the first; the third longer than the first and second combined; last abscissa of cubitus longer than the preceding abscissa; radiella distinct only at base; abdomen broad-oval; first tergite finely rugulose except at extreme base; second tergite broadly emarginate behind, strongly longitudinally rugulose, with a usually distinct fine raised line down the middle; suturiform articulation very broad, coarsely foveolate; third, fourth, fifth, and sixth tergites granular, the third more or less longitudinally sculptured; ovipositor sheaths very nearly as long as the abdomen. Head testaceous, a large median spot on the front and vertex, and the occiput black; thorax black, the parapsidal grooves and a large spot behind middle lobe of mesoscutum ferrugino-testaceous; legs, including all coxae, yellow; the posterior tibiae at apex and their tarsi dusky, wings clear hyaline; abdomen curiously marked: the first tergite black, the second mostly black, with two small basal spots and the middle of the apical margin reddish-yellow; third, fourth, fifth, and sixth tergites black, reddish-yellow medially and at the sides.

*Male.*—Agrees with the female in all essential characters; the antennae are 28-segmented; the sixth abdominal tergite is smooth and polished.

*Type.*—Cat. No. 26666, U.S.N.M.

*Type-locality.*—Altitude, 4,700 feet, Superstition Mountains, Arizona.

*Host.*—*Laemosaccus*, species in *Thurberia.*

Described from seven females and sixteen males reared by H. S. Barber. The number of segments in the antennae varies in this series from 26 to 29. The series is remarkably constant in the striking color pattern.

### 42. MICROBRACON METACOMET Viereck

*Microbracon metacomet* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 206, 208.

*Type.*—In the State Agricultural Experiment Station, at New Haven, Connecticut.

Face and frons finely punctate; antennae broken at tip, 25 segments remaining, very slender, the first flagellar segment nearly three times as long as thick, the remainder twice as long as broad; thorax smooth and polished; legs slender; first abscissa of radius long; the second not distinctly twice the first; the third much longer than the first and second abscissae combined; last abscissa of cubitus decidedly longer than the preceding abscissa; abdomen long, very coarsely granular or rugulose, and nearly as coarsely so on the fifth tergite as on the third; suturiform articulation broad, foveolate, and somewhat arcuate medially, the second tergite being a little emarginate behind; hypopygium large; ovipositor sheaths nearly as long as the abdomen. Face yellow; antennae mostly yellowish; frons, vertex and occiput mostly piceous to blackish; thorax wholly black; legs, including coxae, bright yellow; wings clear hyaline; abdomen mostly blackish above, yellow laterally.

*Distribution.*—New Canaan, Connecticut.

*Host.*—Unknown.

Known only from the unique type.

### 43. MICROBRACON ATRICOLLIS (Ashmead)

*Bracon atricollis* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 622.
*Microbracon nawaasorum* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 205, 207.

*Type.*—Cat. No. 2917, U.S.N.M. The type of *nawaasorum* is in the Connecticut Agricultural Experiment Station at New Haven.

Very distinct from all other species of the genus. Head thick at insertion of antennae; face and frons minutely granular; ocell-ocular line at least three times the diameter of an ocellus; antennae long, slender, usually about 40-segmented, most of the flagellar segments twice as long as broad; thorax long, mostly smooth and polished; parapsidal grooves sparsely hairy; propodeum finely rugulose; metapleura granular; the metapleura and the propodeum laterally thickly clothed with long hairs; posterior tibiae and tarsi slender; last segment of all tarsi long, stout, the claws large; wings long, the entire wing membrane uniformly very densely covered with very short pubescence; stigma rather long and narrow; radius arising at or before its middle and going to extreme apex of wing; first abscissa of radius a little longer than the recurrent vein; the second abscissa of radius more than twice the first; the third as long as the first and second combined and almost on a straight line with the second; the portion of cubitus between recurrent and intercubitus more than half as long as the recurrent; lower side of cubital cell decidedly more than twice the first intercubitus and longer than the lower side of third cubital cell; last abscissa of radius longer than last abscissa of cubitus; cubitus and subdiscoideus nearly parallel, the second discoidal cell not or scarcely broadening toward apex; the chitinized plate of first tergite strongly rugose; second tergite longer than the third, finely granularly rugulose, much less strongly sculptured than first tergite; third, fourth, and fifth tergites very delicately sculptured, the fifth only faintly; ovipositor as long as the abdomen or a little longer. Head yellow; thorax mostly yellow; pronotum above, propodeum, and metapleura partly, blackish; abdomen yellow, the first tergite black, the following tergites more or less blackish medially.

*Distribution.*—? Missouri; Connecticut; Illinois.

*Host.*—Unknown.

Known only from the holotypes of *atricollis* and *nawaasorum*, and one additional female specimen, labeled "Algonquin, Ill. 18-12-95-134, 4855." The only complete antennae are those on the type of *nawaasorum*, which have 43 segments. A thorough study of the types shows *nawaasorum* to be, without doubt, conspecific with *atricollis*.

### 44. MICROBRACON ANALCIDIS (Ashmead)

*Bracon analcidis* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 619.

*Type.*—Cat. No. 2908, U.S.N.M.

Superficially quite similar to *sphenophori*, but differs especially in the thorax being smooth and polished, except on the propodeum which is mostly rugulose. Head thick antero-posteriorly at insertion of antennae; face and frons finely punctate; opening between clypeus and mandibles large, its transverse diameter twice as long as the malar space; antennae 35-segmented, the flagellar segments beyond second but little or no longer than broad; first flagellar segment much longer than second; propodeum rugulose, smooth and shining at base; second abscissa of radius more than twice as long as the first, the latter about half the first intercubitus; abdomen long; first tergite sculptured apically and laterally; second and third very delicately granular, the following smooth and shining; ovipositor sheaths considerably longer than the abdomen. Entirely yellow; wings nearly hyaline; antennae, and the legs including all coxae, yellow.

*Distribution.*—Missouri.

*Host.*—(*Analcis*) *Tyloderma fragariae* Riley.

Known only from the unique type.

### 45. MICROBRACON PODUNKORUM Viereck

*Microbracon podunkorum* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 205, 207.

*Type.*—In the Connecticut Agricultural Experiment Station at New Haven.

Resembles the preceding species in the rugulose propodeum, and the delicately sculptured abdomen, but differs as noted in the key. Antennae 31-segmented, stout, most of the flagellar segments but little or no longer than broad; face and frons finely punctate and opaque; thorax mostly polished; parapsidal furrows sparsely hairy; propodeum completely finely rugulose; second abscissa of radius twice as long as the first; abdomen a little longer than the thorax; plate of first tergite rugulose laterally and at apex; second tergite finely granular with a strongly shining rugulose basal median area; third tergite very minutely granular; fourth and following tergites increasingly faintly sculptured, the fifth and sixth being almost completely smooth; ovipositor sheaths as long as the abdomen beyond first tergite. Yellow; propodeum, first abdominal tergite, and a basal median spot covering the shining rugulose area on the second tergite, black; wings very nearly hyaline; legs, including all coxae, yellow.

*Distribution.*—Branford, Connecticut; Cadet, Missouri.

*Host.*—*Aristotelia absconditella* Walker.

Known only from the holotype, and a single female in the National Collection recorded under Bureau of Entomology number 4575° which was reared December 30, 1889, as a parasite of *Aristotelia absconditella*.

### 46. MICROBRACON MONTOWESI Viereck

*Microbracon montowesi* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 206, 208.

*Type.*—In the State Agricultural Experiment Station at New Haven, Connecticut.

Head not thin, but the temples narrow, receding directly behind the eyes; head broader than the thorax; eyes unusually large, the face hardly broader between eyes than long between the antennal foramina and the lower margin of clypeus; face minutely punctate laterally, smooth and shining medially; frons very weakly punctate, shining; antennae as long as the body, 32-segmented, all the flagellar segments considerably longer than broad; thorax stout, smooth and polished; parapsidal grooves sparsely hairy; propodeum smooth and polished, with a very short stub of a median ridge at apex; first abscissa of radius about as long as recurrent vein; second abscissa of radius about twice as long as the first; abdomen broad-oval; chitinized plate of first tergite almost entirely smooth, slightly sculptured at the apex; second tergite very delicately granular; third and following tergites smooth and shining; ovipositor sheaths less than half as long as the abdomen. Face yellow; frons and vertex mostly piceous to blackish; occiput black; thorax black, with fine ferruginous lines in the parapsidal furrows, and with the apex of scutellum and the propleura, ferruginous; wings very slightly dusky; legs, including all coxae, yellow; the posterior tibiae at apex and their tarsi dusky; abdomen yellow except the first tergite and a basal median spot on the second, which are black.

*Distribution.*—New Haven, Connecticut.

*Host.*—?*Priophorus acericaulis* McGillivray.

The above notes are based on the type. The United States National Museum has two male paratypes, reared with the type from maple leaf-stems infested with larvae of the above-named sawfly. These paratypes agree with the type in the essential characters; the antennae are 28-segmented; the third and fourth abdominal tergites are very faintly partly sculptured.

### 47. MICROBRACON CEPHI Gahan

Fig. 20

*Microbracon cephi* GAHAN, Proc. Ent. Soc. Wash., vol. 20, 1918, p. 19.
*Microbracon cephi* CRIDDLE, Can. Ent., vol. 55, 1923, p. 3.

*Type.*—Cat. No. 21772, U.S.N.M.

Transverse diameter of the opening between clypeus and mandibles much greater than the distance from this opening to the eyes, in the male at least twice as long as the malar space; frons minutely punctate or reticulate; antennae rarely with less than 35 segments; all the flagellar segments considerably longer than broad; thorax long, rather slender, highly polished; parapsidal furrows sparsely hairy; metanotum a little longer than is usual in the genus; propodeum usually longer than first abdominal tergite; last segment of posterior tarsi large, usually fully as long as the second tarsal segment; second abscissa of radius more than twice as long as the first, the third about as long as the first and second combined; last abscissa of cubitus usually a little shorter than the preceding abscissa; abdomen long oval; first abdominal tergite rugulose laterally and apically; second to fifth tergites in the male, second to sixth in the female, granular; ovipositor sheaths not distinctly half the length of the abdomen, usually appearing much less than half. Yellow; usually entirely yellow, or with the mesonotal lobes, propodeum and first abdominal tergite piceous to blackish; rarely with the thorax almost wholly black and the abdomen mostly blackish above; wings a little dusky; legs, including coxae, yellow.

*Distribution.*—North Dakota; Minnesota; Manitoba, Canada. Probably occurs throughout the range of its chief host, the Western Wheat-stem Sawfly.

*Host.*—*Cephus cinctus* Norton.

In addition to the type series the United States National Museum has considerable material, all reared in the Bureau of Entomology, by C. N. Ainslie, from *Cephus cinctus* taken at various points in North Dakota and Minnesota.

### 48. MICROBRACON HEMIMENAE Rohwer

Fig. 11

*Microbracon hemimenae* ROHWER, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 232.

*Type.*—Cat. No. 18434, U.S.N.M.

A very distinct species, combining a black head and black coxae with a sculptured frons and a nearly completely sculptured abdomen.

Malar space in the female nearly as long as the transverse diameter of the opening between the clypeus and mandibles; in the male considerably shorter; postocellar line slightly longer than the diameter of an ocellus; ocell-ocular line less than three times as long as the diameter of an ocellus; antennae about as long as the body, usually 24 to 28-segmented, all the flagellar segments much longer than broad; face and frons minutely punctate or reticulate, opaque; thorax stout, smooth and polished; radius arising before middle of stigma; second abscissa of radius about twice the first; abdomen short and broad, especially in the female; plate of first tergite broad, more or less sculptured; second tergite rugulose, shining; suturiform articulation broad, foveolate; third, fourth and fifth tergites granular; ovipositor sheaths about as long as the dorsum of abdomen beyond first tergite, or nearly. Head black, sometimes with ferruginous orbital lines; thorax black, the parapsidal furrows and a spot behind middle lobe of mesoscutum sometimes ferruginous; wings strongly infumated, more weakly so toward apex; coxae and trochanters black; femora sometimes more or less black; posterior tibiae black except at extreme base; tarsi blackish; abdomen red, the first tergite black; sometimes, especially in the males, more or less of the abdomen beyond first tergite also blackish.

*Distribution.*—Plummer Island, Maryland.

*Host.*—*Hemimene plummerana* Busck.

In addition to the types the National Museum has a large series bearing the same data as the type specimens.

### 49. MICROBRACON OENOTHERAE, new species

Very similar to *mellitor*, from which it differs in having usually a complete median longitudinal carina on the propodeum, in the shorter second abdominal tergite, and the relatively longer flagellar segments of the antennae.

*Female.*—Length, 4 mm.; head rather thick at insertion of antennae; transverse diameter of the opening between clypeus and mandibles but very slightly longer than the distance from the opening to the eyes; antennae 35-segmented, the first flagellar segment twice as long as broad, all the following much longer than broad; face and frons very faintly punctate; thorax stout, smooth and polished; parapsidal grooves sparsely hairy; propodeum polished with a complete median longitudinal carina; second abscissa of radius more than twice as long as the first; the third slightly longer than the first and second combined; abdomen long-oval; plate of first tergite more or less sculptured apically and laterally; second tergite very short, much shorter than the third, with a large median shining rugose area; remainder of second tergite granular; third, fourth, fifth and sixth tergites strongly granular; ovipositor sheaths about as long as the abdomen. Head, thorax and abdomen yellow; antennae blackish; the median line of propodeum dusky; legs, including all coxae, yellow; the middle and hind tibiae and all tarsi more or less dusky or blackish; wings strongly infuscated, especially toward the base.

*Male.*—Agrees in most essential characters with the female. Antennae broken, 28 segments remaining, the flagellar segments nearly twice as long as broad; eyes small; ocell-ocular line about three times the diameter of an ocellus; malar space fully one-third the eye-height; propodeal carina not so distinct as in the type.

*Type.*—Cat. No. 27145, U.S.N.M.

*Type-locality.*—Knoxville, Tennessee.

*Allotype-locality.*—Vienna, Virginia.

*Host.*—*Mompha eloisella* Clemens.

Described from 7 females and one male; the type and two female paratypes were reared from the above host at Knoxville, Tennessee, by C. C. Hill in the Bureau of Entomology, under Knoxville No. 16334; the allotype was reared by R. A. Cushman from *Mompha*, at Vienna, Virginia, under Quaintance No. 7805; two female paratypes were secured by H. B. Weiss from seed capsules of evening primrose in Middlesex Co., New Jersey; and two other paratypes are labeled "On Oenothera, Glendale, Md., H. H. Bartlett, Oct. 23, 1915." All the specimens agree very closely with the type in color and structure; the number of segments in the antennae varies from 33 to 36.

### 50. MICROBRACON PAPAIPEMAE Gahan

*Microbracon papaipemae* GAHAN, Proc. U. S. Nat. Mus., vol. 61, 1922, p. 4.

*Type.*—Cat. No. 24983, U.S.N.M.

Distinguished particularly by the color, the delicate sculpture of the abdomen, the very fine straight suturiform articulation and the long ovipositor, the short and stout antennae, and the sculptured frons. Antennae shorter than the body, 26 to 28-segmented in the type series; face granular; frons finely reticulately sculptured; thorax polished; parapsidal grooves sparsely hairy; propodeum polished, with a short stub of a median carina at apex and a few short ridges diverging from it; second abscissa of radius more than twice as long as the first; the third fully as long as the first and second combined and going to the apex of wing; last abscissa of cubitus no longer than the preceding abscissa; abdomen long-oval; first tergite sculptured laterally and at apex; second tergite granular with a finely rugulose area medially; suturiform articulation very fine, perfectly straight; third and following tergites gradually more delicately sculptured, the fourth and fifth faintly so; ovipositor sheaths nearly as long as the body. Head black, except the face which is yellow; thorax black; wings nearly hyaline; legs yellowish, the hind tibiae and tarsi blackish; abdomen black, the membranous margins of first tergite, the sides of the second tergite and the suturiform articulation, yellow.

*Distribution.*—Rye, New York.

*Host.*—*Papaipema frigida* Smith.

Known only from the four female specimens of the type series.

### 51. MICROBRACON APICATUS (Provancher)

*Bracon apicatus* PROVANCHER, Natural. Canad., vol. 12, 1880, p. 143.

*Type.*—In the Museum of Public Instruction at Quebec, Canada.

The transverse diameter of the opening between clypeus and mandibles slightly greater than the distance from the opening to the eyes; antennae of type broken, 25 segments remaining; the flagellar segments stout, those beyond the second but very little longer than broad; malar space about as long as the first flagellar segment; frons minutely closely punctate or reticulate and opaque; thorax polished; propodeum polished, with a prominent stub of a median ridge at apex and a little fine sculpture adjoining this; second abscissa of radius more than twice as long as the first; abdomen of type missing; head yellow, with a median spot on front and vertex enclosing ocelli, and the occiput, blackish; thorax black, the propleura, lateral anterior angles of mesoscutum, the parapsidal furrows and the space behind the middle lobe of mesoscutum, ferruginous; legs, including all coxae, testaceous; the posterior tibiae at apex and their tarsi, fuscous.

*Distribution.*—Canada; ?Maine; ?Long Island, New York.

*Host.*—Unknown.

The above notes are based on the type. The United States National Museum has two specimens without locality data, one of them called *apicatus* by Ashmead, another from Ottawa, Canada, also named *apicatus* by Ashmead, and two specimens from Long Island, New York, all of which appear to be this species although positive identification is difficult owing to the loss of the type abdomen. The head and thorax, with their appendages, agree perfectly with the type in structure and color, and in placing the species in the key I have considered these specimens to be *apicatus*. The single complete antenna has 30 segments; the abdomen is very delicately sculptured beyond the second tergite; the second is granular; the suturiform articulation, straight, finely minutely foveolate; the ovipositor sheaths as long as the abdomen. One specimen, with 30-segmented antennae, in the collection of the Boston Society of Natural History, was collected by C. W. Johnson at Bar Harbor, Maine. The abdomen of all of these specimens is somewhat longer than suggested by Provancher's description, and the type may be a different species, but the agreement of the antennae, and of the structure, sculpture and color of the thorax, is striking.

### 52. MICROBRACON NANUS (Provancher)

*Bracon nanus* PROVANCHER, Natural, Canad., vol. 12, 1880, p. 143.

*Type.*—In the Museum of Public Instruction at Quebec, Canada; bears yellow label 725.

Frons finely reticulately sculptured and opaque; antennae 24-segmented, the segments of apical half of flagellum scarcely longer than broad; thorax smooth and polished; propodeum polished, with a stub of a median longitudinal ridge at apex and a slight longitudinal impression in front of this stub; radius going nearly to the apex of wing; second abscissa of radius more than twice as long as the first; second abdominal tergite finely granular; third tergite with only a faint suggestion of sculpture; remainder of dorsum of abdomen smooth and polished; ovipositor sheaths as long as the abdomen. Head mostly blackish, face brownish-black; thorax black; wings nearly hyaline; legs, including all coxae, bright testaceous; abdomen black above, the second tergite mostly, the third laterally, and most of the venter, yellow.

*Distribution.*—Canada.

*Host.*—Unknown.

The above notes are based on the type. The only other specimen known to me is a female, without locality data, which is in the United States National Museum.

### 53. MICROBRACON MELLITOR (Say)

Figs. 4, 18

*Bracon mellitor* SAY, Bost. Journ. Nat. Hist., vol. 1, 1836, p. 256.
*Bracon xanthostigma* CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 303.
*Bracon vernoniae* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889, (1888), p. 619.
*Bracon anthonomi* ASHMEAD, Insect Life, vol. 5, 1893, p. 185.
*Bracon mellitor* HUNTER and HINDS, U. S. D. A., Bur. Ent. Bull. 45, 1904, p. 106, fig. 4.—PIERCE, U. S. D. A., Bur. Ent. Bull. 73, 1908, p. 39.
*Microbracon pembertoni* BRIDWELL, Proc. Haw. Ent. Soc., vol. 4, pt. 1, 1919 (1918), p. 115.

*Type.*—The type of *mellitor* is lost; that of *xanthostigmus* is in the Philadelphia Academy of Sciences, and bears No. 1687.1; the types of *vernoniae* (Cat. No. 2909), *anthonomi* (Cat. No. 1360), and paratypes of *pembertoni* (Cat. No. 23615) are in the United States National Museum.

Say's description of *mellitor* will fit any one of several other species of *Microbracon* as well as this species. But since the name *mellitor* has been widely used in literature on economic entomology for the species here treated under that name, and since it is impossible to show conclusively that Say did not actually prepare his description from a specimen of this species, it seems best to continue to use the name *mellitor*. There is tremendous variation in the size of individuals of this species, and with this is combined rather marked variability in structure and sculpture, particularly in the males, which it is often very difficult to identify. The malar space in the female is about as long as the first segment of the antennal flagellum; it is considerably shorter in the male; the antennae are rather stout, and are from 26 to 40-segmented, the smallest number of segments being found in very small males; most frequently the antennae are from 32 to 36-segmented; most of the flagellar segments are usually only a little longer than broad; the thorax is polished; the propodeum with a stub of a median ridge at apex; second abscissa of radius usually not distinctly twice as long as the first; the third not longer than the first and second combined; the radius attaining the wing margin before the apex; abdomen usually broadly oval; the second tergite varying from strongly granular to mostly rugose, nearly always distinctly a little emarginate medially behind; the third to sixth tergites in the female, the third to fifth in the male, granular; ovipositor sheaths at least as long as the abdomen, sometimes considerably longer, a good deal of variation being evident in the same series of specimens. In color *mellitor* is nearly always entirely testaceous or ferruginous, with the propodeum and the first tergite blackish; rarely the thorax has black markings on the mesonotum and pectus.

*Distribution.*—Occurs at least from Texas to South Dakota and eastward to the Atlantic States, where it is found as far north as southern Massachusetts. Also occurs in the Hawaiian Islands; and quite probably is much more widely distributed than here noted.

*Hosts.*—*Anthonomus grandis* Boheman; *A. signatus* Say; *Polychrosis viteana* Clemens; *Pectinophora gossypiella* Saunders. Material from these hosts has been examined. Other hosts, recorded by Pierce, which records are probably correct, include *Anthonomus albopilosus* Dietz, *A. eugenii* Cano, *A. fulvus* LeConte, *A. squamosus* LeConte, *Desmoris scapalis* LeConte.

The National Museum has a large quantity of material of this species reared from the cotton boll weevil, at various points in the cotton-growing area of the United States; also an extensive series reared by R. A. Cushman from the grapeberry moth at Northeast, Pennsylvania, in the Bureau of Entomology under Quaintance numbers, 11100, 11082, 14410, 14472; many specimens from the same host reared by H. G. Ingerson at Sandusky, Ohio; and collected specimens from points in Kansas, South Dakota, Florida, Texas, New

Jersey, Virginia. In the collection of the Boston Society of Natural History are two specimens from Woods Hole and Horseneck Beach, Massachusetts, collected by C. W. Johnson. A study of the types leaves no doubt that *xanthostigmus*, *vernoniae*, *anthonomi*, and *pembertoni* are the same species. The allotype of *vernoniae* is *nuperus*, as stated under that species.

### 54. MICROBRACON NIGROPECTUS (Provancher)

*Bracon nigropectus* PROVANCHER, Natural. Canad., vol. 12, 1880, p. 143.

*Type.*—In the Museum of Public Instruction, at Quebec, Canada.

Malar space about as long as the first segment of antennal flagellum; face and frons minutely granular, opaque; antennae of type missing beyond 10th segment; the flagellar segments beyond second but little longer than broad; thorax smooth and polished; parapsidal grooves sparsely hairy; propodeum is mostly finely punctate, and is provided with a stub of a median longitudinal ridge posteriorly, with some short ridges diverging from this stub; second abscissa of radius not quite twice as long as the first; first abdominal tergite sculptured apically and laterally; second tergite granular, with an irregularly rugose basal median area; third, fourth, fifth, and sixth tergites finely granular; ovipositor sheaths about as long as the abdomen. Head yellow, antennae blackish; thorax yellow except propodeum and mesopectus, which are blackish; abdomen yellow, the first tergite with a blackish spot and third and fourth tergites weakly infuscated medially; wings nearly hyaline; legs, including coxae, yellow.

*Distribution.*—Canada; Vermont.

*Host.*—Unknown.

The above description is based on the type. The only other specimen which I have seen is a female taken at Bennington, Vermont, by C. W. Johnson. This specimen, which is in the collection of the Boston Society of Natural History, was compared with the type, and designated a homotype. The male is unknown.

### 55. MICROBRACON FURTIVUS (Fyles)

Fig. 25

*Bracon furtivus* FYLES, Can. Ent., vol. 24, 1892, p. 34.
*Bracon fungicola* ASHMEAD, Journ. Cincinnati Soc. Nat. Hist., vol. 27, 1895, p. 46.

*Type.*—The types of both species are in the United States National Museum, *furtivus* Cat. No. 14762 and *fungicola* Cat. No. 6864.

This species is extremely variable, especially in color; the specimens of some series are entirely or almost entirely yellow; those of other series are mostly black; all intergradations occur. The antennae are rather slender, all the flagellar segments being considerably longer than broad, and the two basal flagellar segments usually being about equal; face and frons finely sculptured; transverse diameter of the opening between clypeus and mandibles scarcely greater than the distance from the opening to the eyes, in the female; malar space long; propodeum smooth and polished, with a stub of a median ridge at apex; second abscissa of radius usually more than twice as long as the first; last abscissa of radius not longer than the first and second abscissae combined; first abdominal tergite rugulose apically and laterally; second and following tergites granular, opaque; ovipositor sheaths as long as, or a little longer than, the abdomen, and slender, but broadening conspicuously on the apical fifth. Color varying from wholly yellow to mostly black; but face and legs, including coxae, always yellow.

*Distribution.*—From Canada to North Carolina, as judged by the material examined; probably occurs wherever its primary hosts are found.

*Hosts.*—*Gnorimoschema gallaesolidaginis* Riley; *G. gallaeasteriella* Kellicott.

The above notes are based on the types and extensive series in the National Museum reared from *Gnorimoschema gallaesolidaginis* by R. A. Cushman, at Vienna and East Falls Church, Virginia, and northern Pennsylvania, and by R. W. Leiby in North Carolina. At the Gipsy Moth Laboratory there is a series reared from the same host taken at Melrose Highlands, Massachusetts. I have been unable to separate *fungicola* from *furtivus*.

### 56. MICROBRACON TACHYPTERI, new species

Distinguished especially by combining a sculptured frons and a short, broad, sculptured abdomen, with a blackish face and very long ovipositor.

*Female.*—Length, 3.3 mm. Head not thick; temples not broad, receding directly behind the eyes; face receding somewhat below; transverse diameter of opening between clypeus and mandibles nearly twice as long as the malar space and about equal to half the width of the face; malar space much shorter than the first segment of antennal flagellum; ocell-ocular line a little more than twice as long as the diameter of an ocellus; antennae 32-segmented, all the flagellar segments much longer than broad, the first two of equal length and about twice as long as broad; face and frons minutely granular; thorax short, stout, smooth and polished; parapsidal grooves sparsely hairy; propodeum polished, with a short stub of a median longitudinal ridge at apex; stigma large; second abscissa of radius about twice the first; the third a little longer than the first and second combined, and slightly longer than the last abscissa of cubitus; radius going practically to extreme apex of wing; abdomen short and broad; first tergite with the chitinized plate large, strongly elevated posteriorly and rugulose laterally and along apical margin; second tergite short and broad, slightly emarginate medially behind, and finely rugulose or granular; sutiriform articulation arcuate, foveolate; third tergite much more finely sculptured than the second; fourth, fifth, and sixth tergites very delicately sculptured, the sculpture becoming faint on the fifth and sixth; ovipositor sheaths about as long as the entire body. Black; head including the face, except narrowly along the eyes, black or blackish; malar space ferruginous; thorax black, the propleura, parapsidal grooves, and space behind the middle lobe of mesoscutum, more or less ferruginous; legs, including coxae, testaceous, except the apical half of posterior tibiae and the posterior tarsi, which parts are blackish; wings slightly dusky; dorsum of abdomen black, yellowish laterally, the second and third tergites more broadly yellowish laterally.

*Type.*—Cat. No. 26665, U.S.N.M.

*Type-locality.*—French Creek, West Virginia.

*Host.*—*Tachypterus quadrigibbus* Say.

Described from a single specimen reared by F. E. Brooks under Quaintance No. 9521. The United States National Museum has another female specimen of this species labeled "Stony Island, N. Y., July 8, 1896."

### 57. MICROBRACON VARIABILIS (Provancher)

*Opius variabilis* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 382.

*Bracon tortricicola* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 621.

(*Opius rariabilis* PROVANCHER)=*Microbracon dorsator* GAHAN, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 93.

*Microbracon dorsator*, var. *variabilis* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), p. 207.

*Type.*—In the Museum of Public Instruction, Parliament Building, Quebec, Canada. The type of *tortricicola* (Cat. No. 2915) is in the United States National Museum.

Head not thick, the temples receding directly behind the eyes; transverse diameter of the opening between clypeus and mandibles much greater than the distance from the opening to the eyes, in the male fully twice as long as the malar space, in the female one and one-half times as long; face and frons minutely punctate or reticulate; antennae usually 25 to 32-segmented, all the flagellar segments much longer than broad, the first two usually of about equal length and twice as long as broad, the apical segments slender; thorax compact, smooth, and polished; parapsidal grooves sparsely hairy; propodeum polished, with a stub of a median longitudinal ridge at apex; second distinctly longer than the first and second combined; abdomen broad-oval; chitinized plate of first tergite rugulose laterally and at apex; second tergite broad, usually very faintly medially emarginate behind, granular, and usually with a basal median, shining, irregularly rugose area; suturiform articulation rather broad, foveolate; third to fifth tergites, and sometimes the sixth in the female, granular; ovipositor sheaths usually about equal to the dorsum of the abdomen beyond first tergite but sometimes apparently as long as the abdomen. Yellow, more or less marked with black; sometimes entirely yellow; but more frequently with a spot enclosing ocelli, occiput, mesonotal lobes, propodeum, pectus, first abdominal tergite and a basal median spot on second, black or blackish; face always yellow; rarely thorax almost entirely black, and the abdomen largely blackish or dusky above; wings very slightly dusky; legs, including all coxae, yellow, the posterior tibiae at apex and all the tarsi more or less dusky. A study of the types of *variabilis* and *tortricicola* has convinced me that they belong to the same species.

*Distribution.*—Canada, Missouri, Connecticut, Pennsylvania, Virginia, West Virginia.

*Hosts.*—*Polychrosis viteana* Clemens; *Conotrachelus nenuphar* Herbst; Tortricid in seeds of *Ambrosia* (Ashmead); larva in seed-pod of *Oenothera biennis; Tachypterus quadrigibbus* Say.

The above characterization is based on the types, and on a large quantity of material in the National Museum. This material includes extensive series reared by R. A. Cushman from *Polychrosis viteana* at Northeast, Pennsylvania, under Quaintance Nos. 11058, 11070, 11432, and 14462; several series reared from *Conotrachelus nenuphar* by the same investigator, at Vienna, Virginia, under Quaintance Nos. 7025, 7050, and 7837; also several specimens obtained by Cushman from the seed pods of the evening primrose, at Vienna, Virginia, under Quaintance No. 7195; and a single female reared from *Tachypterus quadrigibbus* Say, at French Creek, Virginia, by F. E. Brooks, under Quaintance No. 9505.

### 53. MICROBRACON SANNINOIDEAE Gahan

Fig. 12

*Microbracon sanninoideae* GAHAN, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 196.

*Type.*—Cat. No. 20374, U.S.N.M.

Differs from *mellitor*, to which it is quite similar in general appearance, in having a much larger opening between clypeus and mandibles; in the shorter malar space; in the second abscissa of radius being more than twice the first, and the third longer than the first and second combined; in the posterior margin of the second tergite being straight, and in the tergites beyond the second being more weakly sculptured. The transverse diameter of the opening between clypeus and mandibles is usually twice as long as the malar space; face and frons minutely punctate or reticulate; antennae usually with 30 to 34 segments, the first flagellar segment longer than the second, none beyond the first twice as long as broad; propodeum polished, with a stub of a median ridge at apex; radius going more nearly to extreme apex of wing than is the case in *mellitor;* abdomen long-oval, beyond the second tergite usually very delicately sculptured, the sculpture becoming faint beyond the fourth tergite; suturiform articulation straight, finely foveolate; ovipositor sheaths about as long as the abdomen. Usually entirely yellow, except the antennae and posterior tarsi, but sometimes the thorax, especially on the mesonotal lobes, propodeum and pectus, and the abdomen at base, more or less black.

*Distribution.*—Occurs at least from Connecticut to Georgia, and westward to Kansas and Arkansas.

*Host.—(Sanninoidea) Aegeria exitiosa* Say.

In addition to the types the National Museum has the following material: 2 specimens reared from *A. exitiosa* at Indianapolis, Indiana, by F. N. Wallace; 1 obtained from the same host by E. M. Craighead, at Chambersburg, Pennsylvania; 1 taken on peach at Hamden, Connecticut, by M. P. Zappe; 1 from Riley Co., Kansas (Marlatt); 6 reared from the peach borer at Fort Valley, Georgia, by C. H. Alden; 15 from the same host at Rogers, Arkansas; many specimens reared by E. B. Blakeslee from *A. exitiosa*, at Winchester, Virginia, and collected specimens from Harrisburg and Enterline, Pennsylvania.

### 59. MICROBRACON HOBOMOK Viereck

*Microbracon hobomok* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 206, 208.

*Type.*—In the State Agricultural Experiment Station, at New Haven, Connecticut.

The following notes are based on the type: Malar space nearly as long as the first segment of antennal flagellum; antennae broken, 20 segments remaining, the flagellar segments beyond the first scarcely as long as broad; frons finely sculptured; thorax polished; parapsidal grooves sparsely hairy; propodeum mostly polished, with a stub of a median ridge at apex, a few short ridges diverging from this stub, and the median part of the posterior face somewhat punctate; last abscissa of radius a little longer than the first and second abscissae combined; abdomen long-oval; the first tergite rugulose along the apex; second tergite finely granular; suturiform articulation fine, straight; third to fifth tergites very delicately sculptured, the sculpture becoming faint on the fourth and fifth; ovipositor sheaths as long as the abdomen beyond first tergite. Face yellow; vertex and occiput somewhat piceous; thorax mostly black, the pleura ferruginous; legs, including all coxae bright testaceous; wings very slightly dusky; abdomen yellowish, the first tergite, and a basal median spot on the second, blackish; apical tergites more or less brownish. This species is very similar to *apicatus*, but differs especially in the shorter ovipositor. I have seen no males of either species; doubtless it will be found almost impossible to separate the two species on the basis of this sex.

*Distribution.*—Branford, Connecticut.

*Host.*—Unknown.

Known only from the holotype.

### 60. MICROBRACON CAULICOLA Gahan

Fig. 13

*Microbracon caulicola* GAHAN, U. S. Nat. Mus., vol. 61, 1922, p. 2.

*Type.*—Cat. No. 24982, U.S.N.M.

Closely resembles *mellitor*, but differs in the shorter ovipositor, in the longer flagellar segments of antennae, the usually straight posterior margin of second abdominal tergite; in the second abscissa of radius being much more than twice as long as the first, in the radius going more nearly to the extreme apex of wing, and in the propodeum being usually minutely reticulated over most of its surface. The antennae are usually 29 to 35-segmented, the two basal flagellar segments usually twice as long as thick; propodeum usually delicately reticulated, sometimes granular and more strongly sculptured on the median line; abdomen broadly oval; the first tergite rugulose laterally and at apex, the second coarsely granular or rugulose; the third to sixth tergites in the female, the third to fifth in the male, granular, much less strongly sculptured than the second; ovipositor sheaths nearly as long as the dorsum of the abdomen beyond first tergite. Usually entirely yellow; rarely the propodeum and first abdominal tergite more or less fuscous; wings dusky, the stigma nearly always yellow except at apex; in some small male specimens the stigma is brownish; legs, including all coxae, yellow.

*Distribution.*—Evidently occurs throughout the eastern half of the United States wherever its principal hosts are found.

*Hosts.*—*Pyrausta ainsliei* Heinrich; *P. penitalis* Grote; *P. nubilalis* Huebner.

In addition to the types and the other material mentioned by Gahan as being contained in the collection of the National Museum, there are two specimens received from R. W. Harned, of Mississippi, bearing his No. S4750. At the Corn Borer Laboratory of the Bureau of Entomology, at Arlington, Massachusetts, there is a large quantity from Champaign and Urbana, Illinois. There is also a series in this collection, recorded as probably from *Pyrausta nubilalis*. the introduced European Corn Borer, taken at Woburn, Massachusetts; and a single specimen reared from *Pyrausta ainsliei* by H. W. Allen, at Agricultural College, Mississippi.

### 61. MICROBRACON NIGER (Provancher)

*Opius niger* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 381.
*Microbracon niger* GAHAN, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 93.

*Type.*—In the Museum of Public Instruction at Quebec, Canada.

The following notes are based on the type: Head not thin; frons distinctly finely punctate; opening between clypeus and mandibles small, circular, its transverse diameter scarcely greater than the distance from the opening to the eyes; antennae broken, only 13 segments of one remaining, the other entirely missing; flagellar segments slender, very nearly twice as long as thick; thorax stout, smooth and polished; parapsidal furrows sparsely hairy; propodeum polished, with a short stub of a median ridge at apex and a few short ridges diverging from this stub; radius arising much before middle of stigma; second abscissa of radius fully twice as long as the first; second cubital cell long; third abscissa of radius hardly as long as the first and second abscissae combined; last abscissa of cubitus scarcely as long as the preceding abscissa; second abdominal tergite minutely granular, finely striate medially; third tergite finely punctate; remainder of dorsum of abdomen smooth; ovipositor sheaths about as long as the abdomen behind first tergite. Head black, the face brown; thorax black; wings strongly infumated on basal half; legs yellowish, the coxae more or less dusky above, the posterior tibiae and tarsi dusky; abdomen piceous. A very small specimen.

*Distribution.*—Cap Rouge, near Quebec, Canada.

*Host.*—Unknown.

Known only from the unique type.

### 62. MICROBRACON AEQUALIS (Provancher)

*Bracon aequalis* PROVANCHER, Natural. Canad., vol. 12, 1880, p. 141.

*Type.*—In the Museum of Public Instruction, at Quebec, Canada.

The following notes are based on the type: Face and frons finely sculptured; flagellar segments of antennae considerably longer than broad, the first nearly twice as long as broad; thorax smooth and polished; propodeum with a median carina extending from the apex nearly half way to the base; second abscissa of radius fully twice as long as the first; first tergite sculptured apically and laterally; second tergite finely striate either side of the middle, punctate laterally; third and following tergites faintly punctate; ovipositor sheaths as long as the abdomen beyond second tergite. Face yellow; frons, vertex, and occiput more or less piceous or blackish; thorax black; legs, including all coxae, yellow; wings nearly hyaline; abdomen yellow, first tergite black, the apical tergites brownish.

*Distribution.*—Canada.

*Host.*—Unknown.

The unique type is the only specimen of this species that I have seen.

### 63. MICROBRACON ARGUTATOR (Say)

Fig. 10

*Bracon argutator* Say, Journ. Bost. Soc. Nat. Hist., vol. 1, 1836, p. 233.

*Type.*—Lost.

The species here regarded as *argutator* agrees very well with Say's description, and it seems more desirable to identify it as that species than to describe it as new. Head rather thick at insertion of antennae; temples broad; malar space in the female nearly as long as the first segment of antennal flagellum; antennae normally 25 to 30-segmented, shorter than the body in the female; eyes short-oval; face and frons finely punctate; thorax smooth and polished; parapsidal grooves weakly hairy; propodeum usually mostly weakly reticulately sculptured, and more or less rugulose along the median line; second abscissa of radius about twice as long as the first, the third slightly longer than the first and second combined; abdomen long-oval, the first tergite sculptured apically and laterally; the second granular, usually as long as the first and longer than the third, more than half as long as broad at base; third, fourth and fifth tergites much more delicately sculptured, shining; ovipositor sheaths projecting the length of the abdomen beyond second tergite or a little more. Yellow; sometimes entirely yellow, with only a spot enclosing the ocelli black; the abdomen often of a paler yellow than the thorax; sometimes the occiput, mesonotal lobes, propodeum, pectus and first abdominal tergite more or less blackish; wings slightly dusky, the stigma more or less yellowish; legs, including all coxae, yellow.

*Distribution.*—Indiana; Missouri.

*Host.*—"Lepidopterous larva boring in *Elymus*;" *Saluria*, species.

The United States National Museum has considerable material reared from the above hosts at Lafayette, Indiana and Charleston, Missouri, by C. N. Ainslie, in the Bureau of Entomology, under Webster Nos. 14705 and 14781.

### 64. MICROBRACON GERAEI, new species

Very similar to *argutator*, but distinguished as noted in the table to species.

*Female.*—Length, 3 mm. Head rather thick at insertion of antennae; malar space much shorter than first flagellar segment of antennae; transverse diameter of the opening between clypeus and mandibles very much greater than the distance from the opening to the eyes, and at least one and one-half times as long as the malar space; face and frons very delicately punctate; antennae usually 27 to 33-segmented, slender, usually as long as the body, the first flagellar segment about twice as long as broad; thorax smooth and polished; propodeum finely reticulate or minutely granular and opaque or subopaque; second abscissa of radius hardly twice as long as the first, the third a little longer than the first and second combined; last abscissa of cubitus longer than the preceding abscissa; abdomen long-oval; first tergite rugulose laterally and at apex; second tergite large, about as long as third, and about twice as broad at base as long, granular, often a little rugulose medially; third, fourth, and fifth tergites, and sometimes the sixth, exceedingly delicately sculptured; ovipositor sheaths nearly as long as the dorsum of the abdomen beyond first tergite. Yellow; usually the frons, vertex, occiput and mesonotal lobes more or less black; even in the specimens which have these parts deep black, the propodeum and the abdomen including first tergite are almost invariably yellow; wings very slightly dusky; legs including coxae, yellow, the apical tarsal segment black.

*Male.*—Antennae of allotype 31-segmented; other males vary in this respect, the number of segments being usually 27 to 32. Sometimes the thorax is almost entirely black, although usually at least the pectus and the propodeum are pale; face occasionally with a quadrate blackish spot. In some specimens the fourth and following abdominal tergites are entirely polished.

*Type.*—Cat. No. 26668, U.S.N.M.

*Type-locality.*—Sioux City, Iowa.

*Host.*—"*Geraeus* larva in *Panicum*."

Described from eight female and three male specimens reared by C. N. Ainslie in the Bureau of Entomology, under Webster No. 8885. In addition to the type series there is considerable material in the National Museum, all of it reared from *Panicum* by C. N. Ainslie, at Sioux City, Iowa and Elk Point, South Dakota.

### 65. MICROBRACON LUTUS (Provancher)

*Bracon lutus* Provancher, Natural. Canad., vol. 12, 1880, p. 142.
*Bracon lixi* Ashmead, Canad. Ent., vol. 25, 1[illegible], p. 67.

*Type.*—In the Museum of Public Instruction at Quebec, Canada. The type of *lixi* is in the United States National Museum (Cat. No. 2145).

Very closely related to *variabilis* and often very difficult to distinguish from that species; it is generally more robust, has longer antennae, a slightly longer malar space, and usually slightly shorter ovipositor sheaths. A study of the types of *lutus* and *lixi* has convinced me that they are the same species. Eyes very broad, not distinctly one and one-half times as long as broad, in the female; malar space, in the female, very nearly half as long as the distance from the lower margin of antennal foramina to lower margin of clypeus; antennae usually 36 to 40-segmented; all the segments at least one and one-half times as long as broad; face and frons finely punctate, opaque; thorax stout, smooth and polished; propodeum mostly polished; second abscissa of radius a little more than twice as long as the first; the third slightly longer than the first and second abscissae combined; second abdominal tergite granular, with a shining irregularly rugose area on basal middle; third, fourth, fifth, and in the female, the sixth, tergites finely sculptured; suturiform articulation rather broad, foveolate, usually a little arcuate medially; ovipositor sheaths as long as the abdomen beyond second tergite or a little longer. Yellow; spot enclosing ocelli, and occiput usually blackish; thorax varying from mostly black to blackish only on the mesonotal lobes and propodeum; wings usually slightly dusky; legs, including all coxae, yellow; abdomen yellow, with first tergite and a median spot on second, black; apical tergites usually brownish.

*Distribution.*—Canada; Virginia; New York; Massachusetts; Pennsylvania.

*Hosts.*—*Lixus scrobicollis* Boheman, in *Ambrosia trifida; Papaipema nebris* Guenee.

But little material of this species, in addition to the types, has been seen. The United States National Museum has two specimens reared by H. Bird at Rye, New York, from *Papaipema nebris;* and a collected specimen from Natrona, Pennsylvania. The Corn-Borer Laboratory of the Bureau of Entomology has two specimens reared from *Ambrosia* at Manchester, Massachusetts. All these specimens are females.

### 66. MICROBRACON CERAMBYCIDIPHAGUS, new species

Fig. 16

Very similar to the preceding in habitus, structure and sculpture; it will frequently be found difficult to distinguish them. The characters given in the key together with the description should, however, suffice to separate these two species, at least in the female sex.

*Female.*—Length 3.5 mm. Head about as in *lutus;* temples receding directly behind eyes; malar space as in *lutus;* postocellar line hardly exceeding the diameter of an ocellus; antennae of type 37-segmented, the two basal flagellar segments and also the apical segments twice as long as thick; thorax stout, smooth and polished; propodeum a little roughened medially toward apex; second abscissa of radius more than twice as long as the first; the third a little longer than the first and second abscissae combined; abdomen broadly oval; first tergite with the chitinized plate broad and sculptured apically; second tergite broad, nearly three times as broad at base as long, not at all emarginate posteriorly, granular, with an irregularly rugose area on its basal middle; suturiform articulation straight medially, curving forward a little laterally; third to sixth tergites finely granular; ovipositor sheaths about as long as the abdomen beyond second tergite. Head, thorax and abdomen completely yellow; wings very nearly hyaline; legs, including all coxae, wholly yellow.

*Male.*—Essentially as in the female; the antennae of the allotype are 36-segmented; the malar space is much shorter than in the female; stemmaticum, occiput, mesonotal lobes, pectus, propodeum and spot on first tergite, black.

*Type.*—Cat. No. 26670, U.S.N.M.

*Type-locality.*—Harrisburg, Pennsylvania.

*Host.*—*Oberea*, species in *Crataegus* and *Prunus*.

Described from ten female and two male specimens reared by H. B. Kirk.

The color is more or less variable, but even in the darkest specimens of the type series the abdomen beyond first tergite is entirely yellow.

### 67. MICROBRACON CINCTUS (Provancher)

*Phylax cinctus* PROVANCHER, Natural. Canad., vol. 12, 1880, p. 175.
*Zelè cinctus* PROVANCHER, Addit. faun. Canad. Hymen., 1888, p. 380.

*Type.*—In the Museum of Public Instruction, at Quebec, Canada.

The following notes are based on the type, which is a male: Head not thin; frons polished; transverse diameter of opening between clypeus and mandibles a little longer than the distance from the opening to the eye; antennae broken, 16 segments remaining, none of the flagellar segments twice as long as thick; thorax smooth and polished; parapsidal grooves sparsely hairy; propodeum polished, with a short stub of a median ridge at apex and a slight impression just before the stub; first abscissa of radius fully as long as the inner side of stigma; the second abscissa of radius less than twice the first; abdomen missing; head and thorax black; wings dusky; legs, including all coxae, yellow. Somewhat resembles *meromyzae*, but the thorax is not so long and slender as in that species, the first abscissa of radius is longer, and the propodeum is without the median carina which is usually distinct in *meromyzae*.

*Distribution.*—Canada.

*Host.*—Unknown.

Known only from the broken holotype.

### 68. MICROBRACON WAWEQUA Viereck

*Microbracon wawequa* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 204, 206.

*Type.*—In the State Agricultural Experiment Station at New Haven, Connecticut.

Following are notes made upon an examination of the type, a male specimen in good condition: Head rather thick at insertion of antennae; face and frons smooth and polished; antennae 34-segmented, all the flagellar segments longer than broad, the first distinctly longer than the second; thorax long, rather slender, apparently twice as long as high, smooth and polished; propodeum polished, with a short stub of a median ridge at apex; first abscissa of radius very long, about three-fourths as long as the first intercubitus and more than half the second abscissa of radius; last abscissa of cubitus longer than the lower side of second cubital cell; abdomen long; plate of the first tergite with two elongate pits laterally at apex; medially at apex this tergite is polished; second and following tergites completely polished; suturiform articulation very fine, not punctate or foveolate. Head and thorax wholly black; abdomen piceous black; wings very strongly infumated; all coxae, and fore and middle femora mostly, black; posterior femora black at base on the outer side.

*Distribution.*—New Haven, Connecticut.

*Host.*—Unknown.

Known only from the unique type.

### 69. MICROBRACON SULCIFRONS Ashmead

*Microbracon sulcifrons* ASHMEAD, Bull. 1, Colo. Biol. Assoc., 1890, p. 15.

*Type.*—Cat. No. 13638, U.S.N.M.

Head rather prominent at insertion of antennae, the face receding below; face medially, and the frons, smooth and polished; antennae rather stout, none of the flagellar segments twice as long as thick; thorax stout, smooth and polished; propodeum with a median carina extending nearly half way from the apex toward base and with a few short ridges diverging from this stub; legs of type missing beyond coxae; metacarpus nearly twice as long as the stigma; second abscissa of radius at least twice the first, the third not distinctly as long as the first and second combined; abdomen rather short; first tergite sculptured laterally and apically; second tergite and basal two-thirds of third finely striate; suturiform articulation broad, straight, and strongly foveolate; apical third of third tergite and the fourth and following tergites smooth and polished. Body wholly black; coxae black; wings dusky.

*Distribution.*—Smith's Park Gulch, Colorado.

*Host.*—Unknown.

### 70. MICROBRACON CANADENSIS (Ashmead)

*Opius canadensis* ASHMEAD, Canad. Ent., vol. 23, 1891, p. 4.
*Microbracon canadensis* GAHAN, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 93.

*Type.*—Cat. No. 15061, U.S.N.M.

Somewhat resembles *furtivus*, but the last abscissa of radius is much longer, and the sculpture of the abdomen does not agree with any specimens of *furtivus* examined. Malar space at least one-third the length of the face from antennal foramina to lower margin of clypeus; antennae broken, the segments beyond the nineteenth missing; first flagellar segment about twice as long as broad, the following subequal, about one and one-half times as long as broad; thorax smooth and polished; second abscissa of radius less than twice the first; the third much longer than the first and second combined, and going to the apex of the wing; last segment of posterior tarsi slender; first abdominal tergite sculptured laterally and at apex; the second granular, more or less striate medially; suturiform articulation straight, finely foveolate; the third tergite finely granular; the fourth faintly so, strongly shining; the following smooth and polished. Head piceous black, the face yellow; antennae yellowish beneath toward base; thorax wholly black; legs, including coxae, yellow; wings very slightly dusky; abdomen black, except the second tergite laterally and the suturiform articulation.

*Distribution.*—Ottawa, Canada.

*Host.*—Unknown.

The above characterization is based on the male type, which is the only specimen I have seen.

### 71. MICROBRACON KONKAPOTI Viereck

*Microbracon konkapoti* VIERECK, Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1917 (1916), pp. 205, 207.

*Type.*—In the State Agricultural Experiment Station, at New Haven, Connecticut.

The following notes are based on the type, which is a male specimen: Somewhat resembles *rhyssemati* in habitus and sculpture of the abdomen, but differs in the color of the head, especially the face, and in the sculpture of the propodeum. Face smooth and shining medially; frons very faintly punctate; antennae broken, 20 segments remaining, the first and second flagellar segments of about equal length, twice as long as broad; malar space less than half the transverse diameter of the opening between clypeus and mandibles; thorax rather long and slender, smooth and polished; propodeum polished, with a short stub of a median ridge at apex, and from this stub toward the base medially impressed, almost grooved, the impression traversed by transverse ridges; first abscissa of radius a little longer than the recurrent vein and more than half as long as the second abscissa of radius; radius going to the wing apex, the radial cell broad; first abdominal tergite sculptured at apex; second, third, fourth and fifth tergites rather evenly closely granular, the fourth and fifth a little less strongly so than the second and third. Entire body honey-yellow except the head which is piceous black; the face mostly blackish; legs, including all coxae, yellow; wings slightly dusky.

*Distribution.*—West Thompson, Connecticut.

*Host.*—Unknown.

Known only from the holotype.

### 72. MICROBRACON RHYSSEMATI (Ashmead)

*Bracon rhyssemati* ASHMEAD, Journ. Cincinnati Soc. Nat. Hist., 1894, p. 46.

*Type.*—Cat. No. 1362, U.S.N.M.

Face and frons very minutely punctate; antennae 28 to 30-segmented, all of the flagellar segments much longer than broad; transverse diameter of the opening between clypeus and mandibles at least twice as long as the malar space; thorax smooth and polished; parapsidal furrows very sparsely hairy; propodeum polished, with a median longitudinal carina at least on the apical third, this carina sometimes nearly complete, radius going practically to the wing apex; second abscissa of radius twice as long as the first, the third scarcely as long as the first and second combined; first abdominal tergite finely sculptured at apex; second, third, fourth, and fifth tergites strongly granular, opaque; sixth tergite faintly punctate, shining. Yellow, the mesonotal lobes, disk of first abdominal tergite and the apical tergites very slightly dusky; wings faintly dusky; legs, including coxae, yellow. The female is unknown.

*Distribution.*—Ohio.

*Host.*—*Rhyssematus lineaticollis* Say.

In addition to the three specimens of the type series the United States National Museum has one male specimen from Columbus, Ohio.

### 73. MICROBRACON COOKII (Ashmead)

*Bracon cookii* ASHMEAD, Proc. U. S. Nat. Mus., vol. 11, 1889 (1888), p. 624.

*Type.*—Cat. No. 2921, U.S.N.M.

Very similar to *furtivus;* it cannot be satisfactorily distinguished from that species on the basis of the male holotype, the only specimen of *cookii* that I have seen. This specimen, however, has a large quadrate blackish spot on the face, in which respect it differs from all specimens of *furtivus* examined. The host record, if correct, should leave little doubt that *cookii* represents a distinct species. The following notes are based on the type: Ocell-ocular line about twice as long as the diameter of an ocellus; face and frons very minutely punctate; antennae broken; thorax smooth and polished; propodeum polished; first abscissa of radius about as long as recurrent vein; the second hardly twice as long as the first; the third scarcely as long as the first and second combined; second intercubitus longer than the recurrent vein; chitinized plate of first abdominal tergite broadening rather gradually posteriorly, rugulose apically and laterally; second, third and fourth tergites granular, opaque; fifth tergite very finely granular, shining; frons, vertex and occiput blackish except along the eyes; face with a large quadrate black spot; thorax entirely black; wings very faintly dusky; legs, including all coxae yellow, the posterior tibiae and tarsi more or less dusky; first abdominal tergite and a median spot on the second, black; the apical tergites somewhat fuscous.

*Distribution.*—Lansing, Michigan.

*Host.*—"Leaf-miner in basswood."

Known only from the unique type.

## SPECIES OF MICROBRACON NOT INCLUDED IN THE KEY

### MICROBRACON RUFOMARGINATUS (Ashmead)

*Bracon rufomarginatus* ASHMEAD, Canad. Ent., vol. 25, 1893, p. 68.

*Type.*—I have been unable to locate the type of this species. Judged by the original description it is very similar to, possibly identical with, *politiventris* (Cushman); if the type is found and proves to be *politiventris*, it will be necessary to place the latter name in synonymy.

*Type-locality.*—Morgantown, West Virginia.

*Host.*—Unknown.

### MICROBRACON PICEICEPS (Viereck)

*Bracon piceiceps* VIERECK, Trans. Kans. Acad. Sci., vol. 19, 1905, p. 268.

*Type.*—In the University of Kansas.

It has been impossible to place this species on the basis of the original description and notes by Mr. Gahan who has examined the type, principally because the type is a male specimen and males of the group to which this species belongs are exceedingly difficult to identify. It appears to come nearest to *mellitor.*

*Type-locality.*—Douglas County, Kansas.

*Host.*—Unknown.

## SAY'S SPECIES OF THE GENUS BRACON

When attempting to determine which of Say's species, described in the genus *Bracon*, belong to *Microbracon*, it became necessary to review thoroughly all of the species placed in *Bracon* by Say; and it appears desirable to include in this paper a list of these species with the names of the genera to which they seem to be referable. Some of them have long since been assigned to their proper genera but are nevertheless included here in order to make the list complete. Mr. A. B. Gahan, of the Bureau of Entomology, very kindly aided in these determinations, and the following list expresses both his opinion and that of the writer. The species, the transfer of which has previously been published, are indicated by an asterisk.

| | | | |
|---|---|---|---|
| *argutator* | *Microbracon.* | *pullator* | *Spathius.* |
| **dorsator* | *Microbracon.* | **rugator* | *Campyloneurus.* |
| *exhalans* | *Doryctes.* | *rugulosus* | *Rogas.* |
| **explorator* | *Cardiochiles.* | *scrutator* | *Rogas.* |
| **hebetor* | *Microbracon.* | *stigmator* | *Rogas.* |
| *honestor* | *Spathius.* | **thoracicus* | *Triaspis.* |
| *inescator* | *Spathius.* | **tibiator* | *Cardiochiles.* |
| **ligator* | *Helconidea.* | *transversus* | *Chremylus.* |
| **mellitor* | *Microbracon.* | **trilobatus* | *Triaspis.* |
| *paululor* | *Spathius.* | *truncator* | *Zele.* |
| *pectinator* | *Odontobracon.* | *vestitor* | *Rogas.* |
| *populator* | *Capitonius.* | **viator* | *Cardiochiles.* |

## HOST LIST

### COLEOPTERA

| | |
|---|---|
| *Anthonomus albopilosus* Dietz | *Microbracon mellitor* (Say). |
| *eugenii* Cano | *mellitor* (Say). |
| *fulvus* LeConte | *mellitor* (Say). |
| *grandis* Boheman | *mellitor* (Say). |
| *signatus* Say | *mellitor* (Say). |
| *squamosus* LeConte | *mellitor* (Say). |
| *Chrysobothris deleta* LeConte | *nevadensis* (Ashmead). |
| *Conotrachelus nenuphar* Herbst | *variabilis* (Provancher). |
| *Desmoris scapalis* LeConte | *mellitor* (Say). |
| *Gastroidea cyanea* Melsh | *gastroideae* (Ashmead). |
| *Geraeus*, species | *geraei* Muesebeck. |
| *Laemosaccus*, species | *laemosacci* Muesebeck. |
| *Listronotus latiusculus* Boheman | *punctatus* Muesebeck. |
| *Lixus scrobicollis* Boheman | *lutus* (Provancher). |
| *Oberea*, species | *cerambycidiphagus* Muesebeck. |
| ? *Orthoris crotchii* LeConte | *nuperus* (Cresson). |
| ? *Phytonomus nigrirostris* Fabricius | *tenuiceps* Muesebeck. |
| *Pissodes strobi* Peck | *pini* Muesebeck. |
| *Pityophthorus*, species | *pityophthori* Muesebeck. |
| *Rhyssematus lineaticollis* Say | *rhyssemati* (Ashmead). |
| *Sphenophorus callosus* Olivier | *sphenophori* Muesebeck. |
| *Tachypterus quadrigibbus* Say | *tachypteri* Muesebeck. |
| | *variabilis* (Provancher). |
| *Tychius semisquamosus* LeConte | *tychii* Muesebeck. |
| *Tyloderma fragariae* Riley | *analcidis* (Ashmead). |

### HYMENOPTERA

| | |
|---|---|
| *Cephus cinctus* Norton | *Microbracon cephi* Gahan. |
| *Euura*, species | *angelesius* (Provancher). |
| ? *Priophorus acericaulis* McGillivray | *montowesi* Viereck. |

### LEPIDOPTERA

| | |
|---|---|
| *Acrobasis nebulella* Riley | *Microbracon cushmani* Muesebeck. |
| *Aegeria exitiosa* Say | *sanninoideae* Gahan. |
| *tipuliformis* Linnaeus | *sesiae* Muesebeck. |
| *Archips argyrospila* Walker | *gelechiae* (Ashmead). |
| *paralella* Robinson | *politiventris* (Cushman). |
| *Aristotelia absconditella* Walker | *podunkorum* Viereck. |
| *roseosuffusella* Clemens | *gelechiae* (Ashmead). |
| *Canarsia hammondi* Riley | *cushmani* Muesebeck.<br>*gelechiae* (Ashmead). |
| *Chilo*, species | *pyralidiphagus* Muesebeck. |
| *Coleophora leucochrysella* Clemens | *pygmaeus* (Provancher). |
| *volckei* Heinrich | *pygmaeus* (Provancher). |
| *Coleophora*, species | *juncicola* (Ashmead).<br>*pygmaeus* (Provancher). |
| *Cryptolechia*, species | *psilocorsi* Viereck. |
| *Desmia funeralis* Huebner | *gelechiae* (Ashmead). |
| *Diatraea*, species | *pyralidiphagus* Muesebeck. |
| *Dioryctria abietella* Zinck | *brevicornis* (Wesmael). |
| *Enarmonia prunivora* Walsh | *cushmani* Muesebeck. |
| *Ephestia cahiritella* Zeller | *hebetor* (Say). |
| *elutella* Huebner | *hebetor* (Say). |
| *kuehniella* Zeller | *hebetor* (Say). |
| *Etiella zinckenella schisticolor* Zeller | *hyslopi* Viereck. |
| *Eulia triferana* Walker | *politiventris* (Cushman). |
| *Euxoa*, species | *erucarum* (Cushman). |
| *Galleria mellonella* Linnaeus | *hebetor* (Say). |
| *Gelechia hibiscella* Busck | *gelechiae* (Ashmead). |
| *Gelechia*, species | *gelechiae* (Ashmead). |
| *Gnorimoschema gallaeasteriella* Kellicott | *furtivus* (Fyles). |
| *gallaesolidaginis* Riley | *furtivus* (Fyles). |
| *Hemimene plummerana* Busck | *hemimenae* Rohwer. |
| *Laspeyresia molesta* Busck | *gelechiae* (Ashmead). |
| *Malacosoma constricta* Packard | *xanthonotus* (Ashmead). |
| *pluvialis* Dyar | *xanthonotus* (Ashmead). |
| *Meromyza americana* Fitch | *meromyzae* (Gahan). |
| *Mesocondyla gastralis* Guenee | *cushmani* Muesebeck. |
| *Mineola indiginella* Zeller | *cushmani* Muesebeck. |
| *Mompha eloisella* Clemens | *oenotherae* Muesebeck. |
| *Notolophus oslari* Barnes | *xanthonotus* (Ashmead). |
| *Pandemis lamprosana* Robinson | *politiventris* (Cushman). |
| *Papaipema frigida* Smith | *papaipemae* Gahan. |
| *nebris* Guenee | *lutus* (Provancher). |
| *Papaipema*, species | *gelechiae* (Ashmead). |
| *Pectinophora gossypiella* Saunders | *mellitor* (Say).<br>*platynotae* (Cushman). |
| *Phthorimaea cinerella* Murtfeldt | *gelechiae* (Ashmead). |
| *operculella* Zeller | *gelechiae* (Ashmead). |

| | |
|---|---|
| *Platynota*, species | *Microbracon platynotae* (Cushman). |
| *Plodia interpunctella* Huebner | *hebetor* (Say). |
| *Polychrosis viteana* Clemens | *gelechiae* (Ashmead).<br>*mellitor* (Say).<br>*politiventris* (Cushman).<br>*variabilis* (Provancher). |
| *Pyrausta ainsliei* Heinrich | *caulicola* Gahan. |
| *nubilalis* Huebner | *caulicola* Gahan.<br>*gelechiae* (Ashmead).<br>*hebetor* (Say). |
| *penitalis* Grote | *caulicola* Gahan. |
| *Saluria*, species | *argutator* (Say). |
| *Sitotroga cerealella* Olivier | *hebetor* (Say). |
| *Thurberiphaga diffusa* Barnes | *thurberiphagae* Muesebeck. |
| *Vitula edmansii* Packard | *hebetor* (Say). |
| *Wanda baptisiella* Fernald | *gelechiae* (Ashmead). |

## EXPLANATION OF PLATES

The drawings on Plate 1 are by the writer. The photographs on Plate 2 were taken by Mr. C. E. Hood, of the Bureau of Entomology.

### PLATE 1

FIG. 1. *Microbracon gastroideae.* Front view of head.
2. *Microbracon rudbeckiae.* Lateral view of abdomen.
3. *Microbracon pygmaeus.* Front view of head.
4. *Microbracon mellitor.* Dorsal view of abdomen.
5. *Microbracon melanaspis.* Dorsal view of abdomen.
6. *Microbracon sphenophori.* Lateral view of head.
7. *Microbracon tenuiceps.* Lateral view of head.
8. *Microbracon sesiae.* Lateral view of head.

### PLATE 2

FIG. 9. *Microbracon sesiae.* Anterior wing.
10. *Microbracon argutator.* Anterior wing.
11. *Microbracon hemimenae.* Anterior wing.
12. *Microbracon sanninoideae.* Anterior wing.
13. *Microbracon caulicola.* Anterior wing.
14. *Microbracon pini.* Anterior wing.
15. *Microbracon pygmaeus.* Anterior wing.
16. *Microbracon cerambycidiphagus.* Anterior wing.
17. *Microbracon cushmani.* Anterior wing.
18. *Microbracon mellitor.* Anterior wing.
19. *Microbracon brevicornis.* Anterior wing.
20. *Microbracon cephi.* Anterior wing.
21. *Microbracon tychii.* Anterior wing.
22. *Microbracon rudbeckiae.* Anterior wing.
23. *Microbracon gelechiae.* Anterior wing.
24. *Microbracon erucarum.* Anterior wing.
25. *Microbracon furtivus.* Anterior wing.
26. *Microbracon xanthonotus.* Anterior wing.

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# UNUSUAL FORMS OF FOSSIL CRINOIDS

By Frank Springer,
*Associate in Paleontology, United States National Museum*

## INTRODUCTION

It was originally my intention when preparing the monograph on the Crinoidea Flexibilia to follow it up with a similar systematic treatise on the Inadunata. But the time and labor consumed in bringing out such works proved to be too great, and I have been compelled to relinquish the project for the last-mentioned treatise. Many preparatory studies were made, however, with such a work in view, some of which are embraced in the present paper, containing the results of researches extending over many years, which I have long desired to publish, but which have been delayed by the pressure of other matters. The material used is chiefly from my own collection, now in the United States National Museum, much of it accumulated with special reference to these researches. Most of the drawings have been made by Mr. Kenneth M. Chapman, of Santa Fe, New Mexico, and some by Miss Francesca Wieser, of the National Museum. I am much indebted to Dr. R. S. Bassler and Dr. C. E. Resser, of the National Museum, for their assistance in making the photographs upon which the drawings are based.

## THE USUAL STRUCTURE OF CRINOIDS

The generalized picture of a crinoid, as seen in the forms by which the class is most commonly known, is that of a marine organism having a calyx, cup, or theca composed of calcareous plates definitely arranged, inclosing a cavity which contains the visceral organs; attached to the sea bottom or other objects, temporarily or permanently, by a columnar stem formed by a series of centrally perforated segments; and fringed at the opposite end by a ring of movable, food-gathering appendages called arms; these are likewise built up of calcareous segments, but instead of being pierced by a central opening for a tubular canal, as in the stem, they are notched at one side, forming a groove along which the microscopic food is

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carried by means of currents produced by minute cilia to the oral center, or mouth. The arms when gathering food are stretched upward or outward, but may be folded together when not so employed in such a manner that the vital organs and soft parts are protected by an outer envelope of hard calcareous material. The excrement is discharged through an orifice, either directly piercing the tegmen, or roof, or at the end or side of a projecting tube, or exceptionally through the side wall of the cup.

The plates of which the calyx is composed are arranged usually according to a quinqueradiate plan, most plainly developed on the lower side to which the stem is attached, from which the radiation extends upward and continues into the arms. This is called the dorsal side, in contradistinction to that next to which the arms are located, which is the ventral side or tegmen; and the part of the calyx below the origin of the arms is called the dorsal cup, or simply the cup, which incloses or supports the visceral organs.

This cup in the usual crinoid is made up of a base, consisting either of a single ring of five, four, three, or two plates (or some of these coalesced into a single undivided disk), called basals; or of this and another alternating ring below it of five or three plates (also sometimes fused into one), called infrabasals; and following the basal ring another set of five alternating plates, called radials, with sometimes a ring of interradials in line with them.

The two rings of cup plates—basals and radials—are the fundamental elements of the adult crinoid structure. They are found throughout all the major divisions of the class, and of the blastoids also. In the typical crinoid these two elements are symmetrically arranged in alternating contact with each other, and the radials are symmetric among themselves. This is the plan in the great majority of fossil, and practically all the existing, crinoids. But to this generalized type there are numerous exceptions.

The general tendency of the crinoids as a class, starting in the earliest Paleozoic with the asymmetric form which they inherited from cystidean ancestors, was toward that of complete pentamerous symmetry. This was attained in the Mesozoic and Recent crinoids generally, and in a few genera of the Paleozoic. In most of the Paleozoic crinoids an incomplete pentamerous symmetry was reached, modified by the bilaterial symmetry due to the presence of anal structures. The course of this development was by no means one of continual progress. It was marked by numerous recessions and sudden changes.

Two of the major divisions of the crinoids, Camerata and Flexibilia, and for the most part the third, Inadunata, culminated and were extinguished before the end of the Paleozoic. During this vast stretch of time many peculiar modifications of the type as we chiefly know it occurred, the causes of which are unknown, but which serve as examples of the infinite variety with which the processes of nature go on. Many of these are already well known, and some others it is the purpose of this paper to illustrate. No general discussion of crinoid morphology is here attempted. For that reference should be had to the works of Bather in part 3 of the Lankester Zoology; of Austin H. Clark on the Existing Crinoids; of Wachsmuth and Springer on the Crinoidea Camerata; of myself on the Crinoidea Flexibilia; and to various papers by Jaekel.

I am simply presenting a number of facts, more or less unrelated, bearing upon some of the unusual features and changes above alluded to, by which the general progress of the crinoids in geological time was characterized; together with discussion of some remarkable parallel modifications which I am now able to illustrate more completely than was possible heretofore.

## THE COILED BILATERAL STEM

While the possession of a stem is one of the characters by which the crinoids as a class are best known—so much so that a large part of the early literature treating of them was devoted mainly to discussion of the isolated segments of which it is composed—there was in some instances a remarkable tendency to get rid of it. This appendage probably existed in the larval stage of all crinoids, but in by far the greater part of the existing forms, the comatulids, it is cast off at approaching maturity, and the adult crinoid becomes a free floater. In some, the pentacrinites, it attained a great length; and in some (thought to be due to living on reefs in shallow water) the stem is very short, or even disappears, fixation being accomplished through direct attachment by the fused base.

In most of the Paleozoic genera the stem was present, sometimes attached or anchored by remarkable specialized structures (*Scyphocrinus*, *Ancyrocrinus*, etc.)[1]; in many cases only resting in the soft ooze of the sea bottom by finely pointed terminals, and often not permanently fixed.[2]

The great Paleozoic divisions, Camerata and Flexibilia, and the chiefly Paleozoic Inadunata, had stems with but few exceptions, such as *Edriocrinus* in which the base was fused and attached directly to other objects or became rounded and free from attachment, and *Agassizocrinus* in which a free floating stage in some of its species was also attained. The same thing is true of the Mesozoic crinoids.

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[1] Springer, On the crinoid genus Scyphocrinus, Smiths. Misc. Coll. Publication 2440, 1917, pp. 9–12.

[2] Dr. Edwin Kirk's instructive paper on Eleutherozoic Pelmatozoa, Proc. U. S. Nat. Mus., vol. 41, 1911, pp. 1–137.

A special form of stem development which I wish to illustrate is that in which the usually cylindrical or pentagonal straight stem loses its characteristic shape, becomes coiled, and takes on a bilateral symmetry, by which for the greater part of its length it is flattened or concave at the inner side, with the columnals elliptic or crescentic in cross section; and the cirri, instead of occurring in whorls around the column, are borne only in two rows at or near the margins of the flattened or concave side, or sometimes at the back. This structure is correlated—either as a cause or an effect—with a tendency of the crown to bend back upon the stem, and of the stem to coil around it in the opposite direction in such a way that the crown may be tightly enclosed within the coil and completely enveloped by the cirri. The part of the stem proximal to the calyx is circular in section, much reduced in diameter, relatively short as a rule, but variable in length; and it bears no cirri. The reversed curve is similar to that of a swan's neck, and for convenience the term "neck" may be used for it in the discussions.

This character was evidently protective in origin, as the crown is often very small in comparison with the stem; and in some forms, where the cirri are short and closely packed, the crown is so surrounded by the stem structures that it can rarely be seen in the fossils; while in others, in which the cirri are more scattered but strong and branching, the neck upon which the crown was borne is long, slender, and exceedingly brittle, not tightly rolled, but evidently loosely enveloped in a fringe formed by the strong cirri. Here it must have been very sensitive to disturbance, for in the fossil the stem is almost invariably broken off at the slender neck. In those forms in which the stem was tightly coiled it could be uncoiled and the crown exposed.

This type of stem is found in otherwise unrelated forms from the Silurian to the latest member of the Lower Carboniferous. It occurs irregularly, and so far as yet known, without continuity, and without any definite or exclusive correlation with other characters. After appearing in several Inadunate species in the Niagaran of America, and the Wenlockian of England and Sweden, closely followed by three in the Lower Devonian and one of uncertain relations in the Middle Devonian, the coiled stem structure reappears after a considerable interval in the Burlington limestone of the Lower Carboniferous, but in a different suborder of the crinoids, the Camerata, in one family of which it continues to the end in the upper part of the Chester. Generic names have been given based upon these occurrences; but in the Silurian forms, owing to the closely inrolled condition in which the stems are usually found, the crown is very seldom seen in a state from which the elements of the calyx can be ascertained sufficiently for a proper diagnosis. While there are some well marked differences in the details of the columnals and cirri, which furnish excellent specific characters, it is not practicable to correlate them with other characters to form larger groups; and as to the stem itself, its superficial aspect in some of the Silurian forms closely approximates that in some from the Lower Carboniferous.

So far as can be ascertained, the crown in the Silurian and Lower Devonian forms is of irregular composition, more or less deformed—induced perhaps by the restricted mode of life of the crinoid—and of Heterocrinid type. In some of the Carboniferous species the crown, while otherwise regular, is somewhat deformed by pressure.

It would appear probable, therefore, that this peculiar modification of stem structure is a secondary character, arising from some special condition of life, which may be repeated independently without materially influencing the primary characters upon which genera and families are founded, and therefore of minor taxonomic importance as compared with the great alteration in the superficial appearance of the organism which results from it.

The Silurian form of the crinoid with coiled stem was first described by Hall in 1852[3] under the name *Myelodactylus*, based upon fragmentary specimens from the Rochester shale which he took to be parts of arms. In 1873 Salter[4] described a British species showing the true relation of the crown to the stem, for which he proposed the name *Herpetocrinus*. Angelin in the Iconographia, 1878, described three species from Gotland under Hall's name; and in 1893 Bather, in the Crinoidea of Gotland (p. 36 and following), revised the whole subject, redescribing Salter's species, rejecting all of Angelin's, and adding three new ones of his own. He gave a full summary of all the literature, together with a minute account of the morphology of the stem, with elaborate illustrations which for beauty of execution and fulness of detail leave nothing to be desired. He adopted Salter's name *Herpetocrinus*, rejecting Hall's *Myelodactylus* because he thought it misleading and based upon incorrect interpretation of the structure. In 1895, in an article in the American Geologist (vol. 16, p. 213) Doctor Bather again discussed *Herpetocrinus* in connection with *Brachiocrinus*, another genus of Hall, which he rightly considered to be of the same type, but which he also rejected because, as in his first genus, Hall had mistaken his specimens for arm fragments instead of stem.

Hall's description of *Myelodactylus*, however erroneously conceived as to the nature of the specimens, was accompanied by good figures, by which not only the generic type, but also the two species which he described under it, may be readily recognized. Therefore his name will have to stand, under the rules of nomenclature as now interpreted. Inasmuch as in the type species of *Herpetocrinus*, *H. fletcheri*, as redescribed by Bather, the composition of the calyx has been definitely shown to be essentially that of the Heterocrinidae, but with only four rays, while in at least one of the American species it is now known to be somewhat different, it might be suggested that Salter's name should be retained, at least for that species. But from the little we know of the crown it is probable that the Silurian species in America are similarly deformed, and so the separation of genera on this ground is problematic. Therefore I think it the safe course, with our present knowledge, to treat all the species under the name first published.

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[3] Paleontology of New York, vol. 2, p. 191.

[4] Catalog fossils in the Geological Museum, Cambridge, p. 118.

Six American species have been described: *M. convolutus* Hall and *M. brachiatus* Hall, from the Rochester shale; *M. gorbyi* S. A. Miller, perhaps from the Waldron; *M. bridgeportensis* S. A. Miller, from the Racine dolomite; *M.* (*Eomyelodactylus*) *rotundatus* Foerste, from the Brassfield; *M.* (*Brachiocrinus*) *nodosarius* Hall, from the Helderbergian. To these will be added two new species from the Niagaran; also one from the Keyser, and one from the Linden beds of the Lower Devonian. Furthermore, I have recognized from the American rocks of Niagaran age one of Doctor Bather's Gotland species of the equivalent Wenlockian, which also occurs in England. From data now available as to the occurrence of these several species, it may be said that the Silurian type ranges from the early Niagaran through most of its principal formations, and continues into the Lower Devonian. It has not thus far been recognized from the Middle or Upper Devonian, although a remarkable modification of it is now known from the former horizon and will be herein described, which is perhaps more nearly related to the Lower Carboniferous phase of the coiled stem type.

### Genus MYELODACTYLUS Hall

Plates 1–5

*Myelodactylus* HALL, Pal. New York, vol. 2, 1852, p. 191.
*Herpetrocrinus* BATHER, Crinoidea of Gotland, 1893, p. 36.
Silurian to Devonian.

Hall's generic diagnosis, based on the idea that the coiled stem was an arm, is of no service, but the form can be recognized from the two species which he figured and described. With our present knowledge its characters may be stated as follows:

An Inadunate crinoid with coiled stem, which more or less completely envelops the crown. Stem in proximal region evolute, circular in section, composed of very thin uniform ossicles; in middle and distal regions involute, enlarging, sometimes diminishing again, bilaterally symmetric, elliptic or subcrescentric in section; with two rows of jointed cirri along the margins or the back of the bilateral part varying in arrangement, which may converge over the closely coiled noncirriferous proximal portion like spokes of a wheel. Crown of the type of the Heterocrinidae; without compound radials, and rather resembling *Iocrinus* than *Heterocrinus;* rays irregular, more or less unequal in size, four or five in number; arms dichotomous or slightly heterotomous. (Partly adapted from Bather under *Herpetocrinus.*)

As observed by Bather,[5] the chief diagnostic characters within the genus are furnished by the stem and its appendages. The crown is rarely seen, and owing to pressure resulting from its inrolled habitus the calyx did not have the freedom to develop in the usual way, and is therefore more or less deformed.

Except in the Devonian species, the crown is usually very slender and elongate, so that it can lie along the grooved side of the stem, between the two rows of cirri, without producing any swelling or bulging to indicate its presence. In that condition it is impossible to see anything beyond the general outline of the crown, and we are therefore unable to analyze its composition. In the two cases in which the full contour of the calyx has been seen, one a Silurian and the other a Devonian species, the former has four rays and the latter five. If this difference were known to be constant, it might furnish ground for a subdivision of the genus. But in the presence of so remarkable a specialization the crown was doubtless in a plastic condition, and with the evidence we have, or are likely to obtain, there seems to be no other course than to treat these variations as secondary occurrences, incident to the cramped condition in which the crown habitually grew, which necessarily produced more or less suppression or deformation of the parts subject to pressure.

On the other hand, the stem was a seat of activity unusual in the stalked crinoids, and the cirri took on special functions analogous to those of the comatulids—that is to say, they became active, perhaps prehensile, organs, free to develop according to their conditions; and their modifications, as in the comatulids, furnish important characters for the discrimination of species. Bather suggests[5] (p. 46) that these probably broke off any rooted attachment they may have formed, and that they clung to corals or other objects by their cirri—a mode of life that would furnish the stimulus for numerous variations. This suggestion is reinforced by my observations, showing positively that in some species the stem was free from any attachment whatever.

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[5] Crinoidea of Gotland, p. 45.

Eight or ten different plans of structure and arrangement of the cirri and columnals, some of them widely different, are seen in the material thus far discovered, and in those cases where we are able to test them in considerable numbers of specimens it is found that they hold good with remarkable constancy.

The Silurian species of Europe and American fall into two groups which are somewhat parallel; one in which the cirri, with many variations, are borne upon the margins formed by the two ends of the crescentic or elliptic columnals, which is the most frequent condition, and the other in which they spring more or less from the back of the stem.

As usually found, we have for comparison only the coiled proximal or middle portion of the stem, the longer uncoiled or broadly curved portion being only exceptionally recovered.

If we trace the course of the stem from the point where the slender circular portion proximal to the calyx enlarges and changes to a bilateral form with elliptic section, and the reverse curve begins (regions 1 and 2 of Bather's description), we find that the involute curve usually proceeds for about one to one and a half coils, and then the stem does one of two things; either 1, tapers off rapidly to a narrow pointed end which clings rather closely to the preceding coil; or 2, deviates from this course and goes off in an increasingly wide curve (which sometimes becomes almost straight) for a considerable distance, without any marked diminution in width, probably to a terminal of attachment. The first we call a "close coil," which in some species is all there is; and the second a "loose coil"; and when in the discussion of species measurement is given of the diameter of coil, it means the same thing in both types, namely, the primary coil before the deviation into a broader curve. We can not fix a very accurate limit for this distinction, but it serves a convenient purpose in description. The "close coil" represents the unattached form; the "loose coil" the form which may have been temporarily or permanently attached by the stem to the sea bottom or to other objects.

*Genotype.*—*Myelodactylus convolutus* Hall.

*Distribution.*—Silurian to Lower Devonian; North America, England, Sweden.

### MYELODACTYLUS CONVOLUTUS Hall

Plate 1, figs. 1–8

*Myelodactylus convolutus* Hall, Pal. New York, vol. 2, 1852, p. 192, pl. 45, figs. 5*a*, 6, 6*a*–*h*.

*Herpetocrinus convolutus*, Bather, Crinoidea of Gotland, 1893, p. 48, pl. 2, figs. 50–53.

Coil close in proximal region; open and broadly convolute distalwards. Columnals very short, quadrangular and uniform. Cirri numerous, flat, and closely apposed; regularly paired, one at each side of successive columnals along greater part of stem.

This is one of two thoroughly distinct and well marked forms, both described by Hall when proposing the genus, and illustrated by good figures. It is the most widely distributed species, and the farthest ranging. Bather has described a specimen of it from the Wenlockian of Gotland; and in America specimens which can not be distinguished from it in the condition as found occur in nearly all the formations from the later Clinton through the greater part of the Niagaran. Its range may thus be said to be almost coextensive with the principal Silurian formations of Europe and America.

Hall's type of the species was from the Rochester shale at Lockport, New York. It is rather rare at that locality, only four specimens having been recognized in the abundant material I have from the shales, and one from the underlying limestone of late Clinton age. It has since been found to occur (or two forms indistinguishable from it with our present knowledge) in the Brassfield formation of the upper Clinton in Ohio; the Laurel limestone of Indiana; the Racine dolomite of the Chicago area; and in a closely allied species in the Brownsport limestone of the later Niagaran.

I am now able to illustrate the species more fully than was done originally, showing the extent of the column distally, the distribution of the cirri along the greater part of its length, and some of the slender, circular part leading to the calyx, of which we have the crown partly visible in one specimen, but not enough to determine its structure. As shown by these specimens, the stem beyond the close coil is quite long, and the cirri very narrow, flat and closely packed, so that as seen from either side each columnal bears a cirrus. In the large specimen (pl. 1, fig. 1) the stem extends for 12 cm. beyond the close coil, in which it is 4 mm. wide, maintaining this width to the incomplete distal end. In the St. Paul specimen (pl. 1, fig. 7) the stem is broken off where it was beginning to open a short distance beyond the close coil, and it is of the full width of 4 mm., which is probably maintained for a distance of at least 7 cm. more. There are five other specimens from the St. Paul locality, more or less fragmentary, and in all but one of them the *convolutus* plan of cirri is constant.

The occurrence of this species in the Laurel limestone at St. Paul, Indiana, is an excellent illustration of Foerste's observation[6] that "students of the crinoidea are aware of the frequency with which species occurring at St. Paul find their nearest relatives in the Waldron, Brownsport, and Racine, many of them showing Gotlandian affinities."

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[6] Ohio Journ. Sci., vol. 21, Dec. 1920, p. 64.

I also give for comparison (pl. 1) some figures of the type species of *Herpetocrinus*, *H. fletcheri*, from the Wenlock limestone at Dudley, England, including my own specimen which shows the crown to consist of 4 rays[7]; also Salter's type specimen in the Geological Museum at Cambridge, England, with the crown exposed on one side. In these, and in two other specimens in my collection, the bead-like form of the slender cirri, which is the chief distinctive character separating it from the closely related American species, is thoroughly shown. There is some irregularity in their distribution, as is said by Bather[8]; and I find more alternation in successive columnals than his description indicates. *H. fletcheri* occurs both in England and Gotland, and for a complete revised description see Bather's work previously cited, especially his beautiful figures on plate 2, and details of the stem structure on page 41.

*Horizon and locality.*—Silurian, Rochester shale, and also the later Clinton; Lockport, New York; Brassfield limestone, Xenia, Ohio; Racine dolomite, Chicago; also the Wenlock limestone; Dudley, England, and Gotland, Sweden.

### MYELODACTYLUS BREVIS, new species

Plate 1, figs. 9, 9*a*

I figure under this name a solitary specimen from the Brownsport formation of the late Niagaran, which agrees with *M. convolutus* in all the diagnostic characters of the columnals and cirri, but differs in the extreme shortness of the stem, and the close coil. It has no distal extension whatever beyond the tightly rolled coil, as is shown by the rapid taper, which is evidently very near the end. While the specimen may be sporadic amid the great abundance of the prevalent species of that horizon, yet the agreement with the form from the Rochester shale in the essentials of cirri structure is so complete that it can hardly be ignored, while at the same time the close coil, terminating in a point, is shown by abundant material in another form to be a good specific character.

*Horizon and locality.*—Silurian, Brownsport formation; Decatur county, Tennessee.

### MYELODACTYLUS AMMONIS (Bather)

Plate 2, figs. 1–9

*Herpetocrinus ammonis* BATHER, Crinoidea of Gotland, 1893, p. 49, pl. 2, figs. 54–63.

Coil very close, stem short, extending but little beyond the proximal part of the involute coil; wide in the middle region and tapering to a point at the distal end. Cirri numerous, short, flat and closely apposed; either regularly paired on alternate columnals, or regularly alternating, one from the broad end of successive columnals. Crown usually concealed by the coil; its detailed structure unknown.

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[7] Mentioned by Bather in Crinoidea of Gotland, p. 182, under fig. 38.

[8] Crinoidea of Gotland, p. 46.

Among the collections made for me by Professor Pate in the Brownsport formation of Decatur county, Tennessee, are upwards of fifty specimens belonging to this genus. With a solitary exception they all have alternating columnals according to one of two plans: either 1, long, hourglass-shaped ossicles as seen from the inner side, with a cirrus at each end and a shorter, lenticular, non-cirriferous ossicle interposed; or 2, uniform wedge-shaped ossicles, with a cirrus springing only from the broad end of each. The cirri are in close contact, short, tapering rapidly, when intact meeting at the center of the coil, or slightly overlapping at the smaller ends—thus filling the entire visible space with a conspicious convergent structure. Seen from either side, there is one cirrus for every two columnals. The difference between this form and *M. convolutus* is readily apparent. The latter has twice as many cirri, which are relatively only half as wide, as the former. In the exception above mentioned the specimen differs so decisively in structure that I have separated it as *M. brevis.*

These specimens fall into two categories: 1, with a short stem, closely coiled, the distal end tapering while still in contact with the coil, thus indicating that it did not extend much farther, and in fact, when not broken off, narrowing to a point; 2, with stem much elongated, extending by broad curves beyond the small proximal coil, without noticeable dimunition in width to near the distal end—sometimes becoming almost straight. This difference is not due to age, for both large and small individuals have an open coil, while those that are closely coiled are sometimes quite robust, although generally smaller than the former.

These forms constitute two well marked subdivisions of the type under consideration, each numerously represented among the material from the Decatur County area. In a few specimens where the stem is broken off close to the proximal region of the coil the identification is uncertain, but in most cases one can determine from the condition at the point of fracture whether the stem is beginning to taper distalward or not; and the two structures impart a certain superficial aspect by which, when once understood, the forms are readily recognized. In specimens which are nearly complete the difference is apparent at a glance.

Each of these divisions includes specimens with both types of columnals as above described, which I have been unable to correlate with any other character for a further and desirable subdivision. Bather, when describing his *H. ammonis*, recognized two varieties based upon these characters, which he called *bijugicirrus*, with the hourglass-shaped, and *alternicirrus*, with the wedge-shaped, ossicles. He did not think it advisable to separate them as species, because he found the structures somewhat intermingled in his principal type specimen, and also in view of the practical difficulty of distinguishing them owing to the fact that the stem in both varieties, as seen from the outer curve, and also from the side, presents the same appearance, it being usually only on the inner curve that any difference is apparent. I have found the same difficulty, and among the numerous specimens now in hand there are several, otherwise well preserved, which I should be unable to identify upon this character alone. The intermingling of the two varieties is well shown on plates 2 and 3, and in one fragment from St. Paul (pl. 3, fig. 12) both are seen to exist in the same specimen.

Out of 22 specimens of this species in which the form of the columnals can be readily observed, 13 are of the variety *bijugicirrus* and 9 of variety *alternicirrus*. And among 21 specimens of the species with the loose coil, *M. extensus*, 7 are of variety *bijugicirrus*, and 14 of variety *alternicirrus*. Thus while the two characters are so intermingled as to preclude the basing of species upon them, yet on the strength of preponderance in numbers the evidence of these varieties may be considered as confirmatory of the separation of the two species which we have made upon other grounds.

I have referred the close coiled form to *M.* (*H.*) *ammonis*, on the strength not only of Bather's statement in the specific diagnosis, but of the measurements which he gives on page 50, showing the diminution in width of the stem in a distal direction, and of his figure 56 on plate 2, which bears a striking resemblance to many of my specimens. For the form with the loose, extended coil I am proposing the new species, *M. extensus*. From the evidence of specimens which I have from Dudley, I judge that the two types with the close and open coil exist among the English forms also.

The recognition of this Swedish and English species in the American rocks of equivalent age adds another fact to the evidence of the close relationship between the Silurian faunas of the two regions.

As a rule the specimens are tightly inrolled, so that the cirri are usually better preserved than in the open coiled form. They have a very compact, robust, and well-rounded appearance. The stem swells from the proximal region to a considerable width (often wider than in open coiled specimens of much greater length) at about midway of the exposed part, and from there diminishes to a narrow point at the distal end, which is just beyond the last contact with the preceeding coil (pl. 2, fig. 3*a*). Usually this narrow terminal is broken off, but it is present in several specimens (pl. 2, various figures);

even when detached the taper in width of the stem for some distance back is plain to the eye. The diminution is decisively shown by measurements. In six specimens having the stem complete to the narrow distal end, with diameters of coil from 20 mm. down to 12 mm., the diminution from the widest median part to the distal end is from 5—5—4—4—3—2.5 mm. down to 1 mm. or less; whereas in the five largest specimens of the open-coiled form, with diameters in the corresponding part of the coil of from 24 to 14 mm., the average maximum width is 3 mm., only reaching 4 mm. in one case; and this width is in most cases maintained with but little diminution so far as the stem is preserved. In the largest specimen, with stem extending about 8 cm. beyond the coil, the width is still 3 mm. at the incomplete distal end. In one of the six close-coiled specimens above mentioned, having diameters of 12 and 14 mm., the distal portion diminishes in width from 4 mm. to a point in a distance of only two and a half times its maximum width.

In the present species the involute, or bilateral, portion of the stem is limited to about one and a half convolutions with diameters ranging from 9 mm. to a maximum of 24 mm., while in the open-coiled form there may be one or two more loose coils, with the stem extending still farther in a broad curve, or nearly straight.

In many of the specimens the two outer longitudinal sutures, remnants of the primitive five by which the stem was originally divided, are very prominent (pl. 2, fig. 2*a*), and the stem between them is often raised into a rounded ridge, as mentioned by Bather under *H. ammonis.*[9]

There is no doubt that this form, with its abbreviated and rootless stem, led a free life; whereas it is probable that the other form, with elongate stem, was sessile, temporarily or permanently.

In addition to the specimens from the Decatur County area, I have about an equal number from the Waldron shale at Newsom, Tenn., which I am unable to distinguish from them by any characters disclosed in the fossils, and which have a remarkable uniformity in the characters above desscribed. Hence notwithstanding the difference in horizon, they will with our present knowledge have to be referred to the same species. So far as observed, the form with the open coil does not occur at the Waldron locality.

This description is based upon about forty specimens, almost equally divided between the two localities.

*Horizon and locality.*—Silurian, Brownsport formation; Decatur County, Tennessee; and Waldron shale, at Newsom, Tennessee. A small fragment from St. Paul, Indiana, shows that this or the following species exists also in the Laurel formation; it has the cirri paired on alternate columnals, the cirriferous ossicles having an hour-glass shape as seen from the inner side of the curve, with a shorter, lenticular one between them (pl. 2, fig. 5). Also Wenlockian. Gotland, Sweden, and probably Dudley, England.

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[9] Crinoidea of Gotland, p. 51.

### MYELODACTYLUS EXTENSUS, new species

Plate 3, figs. 1–13*a*

Like *M. ammonis*, except that the coil is open beyond the proximal region; stem elongate and extended for a considerable distance in a broad curve toward the distal end.

This species, differing from the preceding only in the extent and mode of termination of the stem, is represented by a series of about 30 specimens, which for the most part are considerably the largest of the two. In diameter of the corresponding coil they range from 12 mm. to 30 mm., to which must be added the extension of the stem after deviating from the coil. In one specimen with the close coil about 25 mm. in diameter the total length of the bilateral part of the stem is about 16 cm., of which more than half lies beyond the region of the coil, without reaching the distal end, and with but little diminution; and it is almost straight (pl. 3, fig. 1). In another, in which the coil is loosely maintained in large curves, the stem is preserved to near the distal end, where it seems to terminate in some small radicular cirri (pl. 3, fig. 3). Another specimen has a close coil of 12 mm., from which it opens in a broad coil for one and a half whorls more for about 12 cm., maintaining a width of about 3.5 mm. to near the distal end, where it diminishes to 2.5 mm. (pl. 3, fig. 5). Another, not figured, has the stem extended beyond the point of deviation for a distance of 12 cm. and is still large, having diminished in width from 5 mm. in the median part to 4 mm. Besides the other specimens with long extension shown on the plate, there are three more with incomplete extended part from 4 to 6 cm. long, with little or no diminution, thus giving ten specimens in which this character is strongly emphasized, in contrast to the still greater number belonging to *M. ammonis* in which the stem is restricted to the close coil with its pointed distal end. The small size in which this form also occurs is shown by figures 10 and 11 of plate 3.

The open coiled form would seem to be favorable for the discovery of the crown; and in view of the fine preservation of many of the specimens from the Decatur county locality I fully expected to find it. But after diligent search I was only able to uncover it, in imperfect condition, in a few specimens, not well enough preserved to show the composition of the calyx. I then tried grinding, and after several failures succeeded in getting a polished section giving the outline of the crown. All that it shows is that the arms are long and extremely slender, with calyx evidently of the heterocrinid type (pl. 3, fig. 7). To judge by the space it occupies this crown may have only four rays.

On plate 9, figure 10, there is a picture of a round stem spirally coiled and tightly wound about another crinoid stem, without any trace of bilateralism. It is shown here in order to caution observers against being misled by a superficial resemblance, in view of the fact that coiled stem fragments like this, attached to other objects, are not uncommon in the same Silurian formation of Tennessee which contains species of *Myelodactylus* herein described. Such a piece was figured by Roemer in Silurian Fauna des Westlichen Tennessee, 1860 (pl. 4, figs. 11*a*, *b*, *c*) and discussed on page 57. These spiral stems have not been found in connection with the corresponding crown or calyx. But this form has nothing whatever to do with the bilateral stem of *Myelodactylus*, and belongs to some entirely different group.

These two kinds of stem have formed the subject of an elaborate paper by Dr. K. Ehrenberg upon Coiled Stems in the Pelmatozoa and their relation to Sessility,[10] which only came to my attention after the present memoir was nearly completed. In it he refers to another paper devoted especially to *Herpetocrinus* soon to appear, but which I have not seen.

Doctor Ehrenberg divides the crinoids with coiled stem into two general types, the first with nonbilateral stem in which the coiling is more or less limited to the distal part—which would be like the specimens above mentioned; and the second in which the stem is bilateral, and coiled throughout its entire length, such as *Myelodactylus* (*Herpetocrinus* as he prefers to call it) and similar forms. The first type, being capable of attachment by its coiled distal end to other objects, he considers to be adapted to a sessile mode of life. In the second, where the coiling involves the entire stem, and the crown is enveloped within it, there is no indication of sessility, but it had a vagrant, pelagic habitus, somewhat like that of the Ammonites. In each type the coiling must be viewed as an adaptation to its particular mode of life.

I do not here attempt to follow the author's discussion of the origin of the coiled stem, and its bearing upon the phylogeny of the Pelmatozoa, but I hope the new facts now being brought out may throw further light upon that phase of the subject.

*Horizon and locality.*—Silurian, Brownsport formation of the late Niagaran; Decatur County, Tennessee.

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[10] Acta Zoologica, Vienna, 1922, vol. 3, p. 271, and following.

### MYELODACTYLUS BRIDGEPORTENSIS S. A. Miller

*Myelodactylus bridgeportensis*, S. A. MILLER, Journ. Cin. Soc. Nat. Hist., sec. 2, vol. 3, 1880, p. 141, pl. 4, figs. 2*a*—*e*.

### MYELODACTYLUS GORBYI S. A. Miller

*Myelodactylus gorbyi*, S. A. MILLER, 17th Rep. Geol. Surv. Indiana, 1891, p. 72, pl. 2, figs. 6, 7.

When describing these species Mr. Miller still clung to the idea that they represented the arms of a crinoid, and his statements therefore throw no light upon their specific characters. Both were described from rather poor material, but under the first one, from the Racine dolomite of the Chicago area, there is enough detail in the figures to show that it is of the type of *M. convolutus*, having paired cirri on every columnal; and, so far as appears from the specimens, it should be referred to that species. As to the second species, *M. gorbyi*, said to be from the Niagara limestone near Nashville, Tennessee, the single small type specimen as figured shows no diagnostic character whatever. Nor is there any information to indicate its exact horizon—there being more than one Niagara formation in the vicinity of Nashville. It possibly was from Newsom, which is in that vicinity, but whether it belongs to the same species as the specimens from that locality mentioned under *M. ammonis*, can not be ascertained from the figure or description, and the location of the type is unknown.

### MYELODACTYLUS ROTUNDATUS (Foerste)

*Eomyelodactylus rotundatus* FOERSTE, Bull. 19, Sci. Lab. Denison Univ., p. 19, pl. 1, fig. 8; pl. 2, fig. 3.

Under the name *Eomyelodactylus* Foerste has described a specimen from the Brassfield formation of Ohio, equivalent to the late Clinton, which has all the characters of *M. convolutus*. As already stated, this species occurs both in its typical horizon, the Rochester shale, and the underlying Clinton limestone at Lockport, and therefore may well be expected in the Brassfield.

### MYELODACTYLUS BRACHIATUS Hall

Plate 4, figs. 1–10

*Myelodactylus brachiatus* HALL, Pal. New York, vol. 2, 1852, p. 232, pl. 45, figs. 7*a*–*e*.
*Herpetocrinus brachiatus*, BATHER, Crinoidea of Gotland, 1893, p. 46.

Coil open; circular part of stem very long and slender. Cirri few, round, limited to the distal region, and branching; springing alternately from the back of the stem at intervals of several columnals. Crown small, superficially resembling *Iocrinus*, but calyx elements not fully known.

Hall's description has scarcely anything of diagnostic value, being based, like that of *convolutus*, upon the idea that the fossils before him were the arms of a crinoid. But his figures clearly show the important fact that the cirri are few, originating at alternate intervals from the back of the stem. These characters enable us readily to identify the prevalent form of the genus occurring in the Rochester shale at Lockport, New York. I have upwards of seventy specimens, assembled from the extensive collection of Doctor Ringueberg, and the fruits of three seasons' work in the shales at Lockport by Frederick Braun. This material brings out the further remarkable fact, unknown to Hall, that the cirri are branching—a character which I believe to be hitherto unknown in any crinoid, fossil or recent, except in cases where the cirri belong strictly to the root.[11]

This fact emphasizes the broad distinction between the two original species from the type locality, the characters of *M. convolutus* being in strong contrast to those of *M. brachiatus* in almost every particular. Instead of the cirri being short, flat, numerous, and extending well toward the proximal region, as in the former species, here there are but few of them, at intervals of several columnals, springing from the back instead of the lateral margins, and restricted to the distal region of the stem. But what they lack in number they make up in size. Notwithstanding the fine preservation of many of the specimens, in which the strong, round cirri are present to the extent of several branches, it is doubtful if we have the cirri preserved to their full length in any of them. But it is evident that in many cases—perhaps always—they exceeded in length the entire elliptic or crescentic portion of the stem, so that with their numerous branches they formed a complete fringe, by which when retracted by its slender neck the crown was surrounded without being closely infolded as in *convolutus* and species of similar type We have the stem preserved to the distal end, where it becomes round and tapers rapidly to a point.

Among the material obtained by Braun during his campaigns at Lockport in the years 1910, 1911, and 1914, were a number of specimens in which the thick distal and median portion of the stem was seen imbedded in a fine-grained matrix favorable for preparation. Upon carefully following this up, I came first to the slender neck forming the round part, which proved to be unexpectedly long, and after executing a doubly reversed curve passed out of the coil and finally terminated at the crown, which thus assumed an erect position. It is small and fragile, and while the arms are preserved to nearly their full length the structure of the calyx can not be fully made out, so that beyond its *Iocrinus*-like appearance not much can be said about it. Encouraged by this favorable beginning in the new material, expectation was aroused that we should soon have the desired information as to its exact structure. The second specimen investigated followed the same course as the first until the slender neck of the stem turned outward from the coil, and then it suddenly came to an end, broken squarely off, with the crown absent And although I worked every specimen, thirty-four in number, in which the favorable condition appeared, the same result followed. In every one of them the crown was gone—snapped off at time of death. This form must have been peculiarly sensitive to disturbance or change of conditions, causing it to cast off the crown, as certain existing crinoids cast off their arms on being brought to the surface.

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[11] A figure in Goldfuss (Petrof. Germ., vol. 1, 1829, p. 190, pl. 58, T. fig. 7, Z), under the heading of *Cyathocrinus pinnatus* Goldfuss, of a fragment from the Devonian of the Rheinland, seems to show a coiled bilateral stem, with two marginal rows of cirri, which fork at a distance of several ossicles from the stem. There is nothing to indicate its relation to other forms, not even to the other fragments figured under the same name; and it may be an arm trunk of some Melocrinid.

Conformably to the habitus thus described, I do not find in this species the close coiling of the stem in the proximal region as in the other species. The contrast in thickness between this part of the stem and that lower down is very great. The broad curve in the latter part is always conspicuous, terminating when sufficiently preserved to show it in a pointed end.

In a maximum specimen the diameter of the coil is 15 mm.; length of stem from coil to distal end is 30 mm.; and of the part included in the coil about 35 mm., to which must be added that of the circular part, 20 mm., making the total length of stem 10 cm. Width of stem in middle region 4 mm., in circular proximal part 1 mm. Length of an upper cirrus, branching four times, 2.5 cm.; lower cirri, not fully preserved, undoubtedly much longer. Maximum number of cirri about 12 or 13, at intervals of about 6 or 7 columnals between the cirri at each side. The columnals are quadrangular, very short, and of uniform length, about .5 to .8 mm. The diameter of an average cirrus at its base is 1.5 mm., so that its socket may abut upon 2 or 3 columnals. Minimum specimens may have a diameter of coil of 7 mm. or less, with other dimensions in proportion.

This species is comparable to *Herpetocrinus flabellicirrus* Bather, from Gotland, in the fact that the cirri spring from the back of the stem and are confined to the distal region, but in no other important character. In the Gotland species, instead of single cirri at intervals, there are large cirri separated by several columnals bearing successively diminishing cirri, arranged so as to form a fan-like cluster. Compare Bather's figure 68 of plate 2, with figure 5 of plate 4 herein.

*Horizon and locality.*—Silurian, Rochester shale; Lockport, New York, where it is one of the leading crinoid species. No trace of it has been seen in other horizons in which the genus occurs.

### MYELODACTYLUS KEYSERENSIS, new species

Plate 6, figs. 1–3

Coil open, with stem diminishing but little distalwards. Cirri numerous, long, slender, closely apposed, slightly rounded but not moniliform; mostly paired on successive columnals. Crown large, with long arms branching repeatedly; its bulk producing a noticeable swelling of the two rows of closely packed cirri inclosing it. Rays 5, irregular, of the *Iocrinus* type, the anal tube borne on the left shoulder of r. post. Rs.

This species differs from all Silurian forms in the conspicuous bulging caused by the large size of the crown. I have nine specimens from the Keyser beds, in all of which the presence of the crown is indicated by this feature. In size, shape, and distribution of the cirri this form does not differ essentially from *M. convolutus*, but the bulkiness of the crown differentiates the two readily.

In two of the specimens the crown is well exposed, so that its composition may be studied. The swelling is not due to the calyx, but appears in the arm region, leading to the inference that it is caused by an inflated anal tube or sac, such as occurs in *Ohiocrinus*, and, though rarely seen, in *Anomalocrinus*. The rays differ greatly in size in the one specimen in which they can be fully observed (pl. 6 figs. 1–1*c*); *r. post.* and *r. ant.* being narrow, the other three much wider; *l. ant.* the widest of all, and branching higher up than the others. The difference in the development of the rays is connected with their relative position in the curvature of the crown. The largest one, *l. ant.*, being at the outside of the curve, was freest to develop and filled the greatest space; whereas *r. post.* and *r. ant.* were much cramped at the inner side of the curve, compressed, and dwarfed in their growth, especially *r. ant.*, which does not branch at all. The first bifurcation in the others is at different heights, and beyond that the arms branch five or six times to very fine finials.

In the two largest specimens, having diameters at the close coil of about 30 mm., the stems extend for 5 and 6 cm. beyond that, and are 4.5 and 5.5 mm. in width, without noticeable diminution; in these the thickness of the swollen part is 6 and 12.5 mm. respectively, being thus about double the width of the stems. In another large incomplete specimen the swelling is 15 mm. thick (pl. 6. fig. 3); and a smaller specimen, with a coil 18 mm. in diameter, has the swelling enlarged to 15 mm.

*Horizon and locality.*—Lower Devonian, Helderbergian, Keyser formation; Keyser, West Virginia.

### MYELODACTYLUS NODOSARIUS (Hall)

Plate 5, figs. 1–8.

*Brachiocrinus nodosarius* HALL, Pal. New York, vol. 3, 1859, p. 118, pl. 5, figs. 5, 6, 7; pl. 6, figs. 1, 2, 3.

*Herpetocrinus nodosarius*, BATHER, Amer. Geol., vol. 16, 1895, pp. 213, 217.—*Brachiocrinus* (*Herpetocrinus*) *nodosarius*, TALBOT, Amer. Journ. Sci., 20, 1905, p. 32.—*Brachiocrinus nodosarius*, KIRK, Proc. U. S. Nat. Mus., vol. 41, 1911, p. 48.—*Brachiocrinus nodosarius*, GOLDRING, Devonian Crinoids of New York, 1924, p. 332, pl. 41, figs. 1–4.

Coil open. Stem elongate, extending without sensible diminution considerably beyond the coil, terminating in a bulbous enlargement; columnals short, uniform. Cirri few, short and thick, composed of a few rounded cirrals; moniliform, thickest about the middle, where their diameter often exceeds that of the stem from which they spring; alternating, at intervals of usually 1 to 5 columnals.

The most remarkable thing about this Lower Devonian form is the ponderous character of its rounded, bead-like, doubly tapering cirri. In this respect it evolved an unparalleled modification, for in no other known crinoid are the cirri thicker than the stem on which they are borne. Here they are often very much thicker. In three specimens with stems 3 mm. wide many of the cirri are 4 mm. in width; and in all the ten specimens in hand the cirri are nearly all as thick as, or thicker than, the stem. There is considerable irregularity in the size of the cirri, and one gets the impression of hypertrophy due to some unusual stimulus.

Some are decidedly swollen in the middle, increasing in size for a few ossicles, and then diminish to sharp extremities. Some are about equal throughout, and often both kinds are seen in the same specimen; usually the first cirral is shorter than those directly following it. The cirri originate along the curved outer margins of the modified stem, alternately at the longer face of successive cuneate columnals, giving them often the appearance of being opposite, and in pairs. Beginning at the distal end of the stem, the first few cirri are in close contact, but higher up they are separated by increasing intervals of one to five columnals, which are short and equal. Occasionally the two cirrus-bearing columnals are fused.

The cirri are few in number, not exceeding eight to ten pairs in the longest stems observed, which are 5 to 10 cm. in length, without being complete. One of these is almost straight for its entire length. The proximal part of the stem, and also the crown, are unknown.

Another character wherein this form is unique among its congeners is that the distal end of the stem terminates in a rounded condyle having the appearance of a secondary growth after fracture of the stem from its original attachment. This is not a mere casual occurrence; in seven specimens, with the distal end preserved, six have a bulbous termination, and the seventh is irregularly enlarged, followed by a short tapering appendix.

The only other known species possessing medially swollen cirri is *H. flabellicirrus* Bather, from Gotland, in which they are thickly crowded, in fan-like clusters, and originate at the back side of the stem.

The material available for this investigation consists of eight specimens in the New York Museum at Albany, most obligingly loaned me by Dr. John M. Clarke, in which are included two of Hall's types.[12] In addition to these I have had the use of some fragments from a different locality showing the full rotundity of the bulbous distal end, for which I am indebted to the courtesy of Prof. Charles Schuchert of the Yale University Museum. The other specimens figured by Hall I have not been able to locate. One of them[13] has about 10 cm. of the stem, with the curvature toward the proximal coil well shown, but not, however, either the proximal or distal end.

I see no reason to doubt the conclusion reached by Bather in his discussion of 1895 that this species is congeneric with those which he referred to *Herpetocrinus*. The difference from the typical forms in the character of the cirri is of course very great, but not relatively more than that of some of the other species, such as *flabellicirrus* or *brachiatus*, while the general type of stem construction remains the same.

*Horizon and locality.*—Lower Devonian, Helderbergian, New Scotland formation; Schoharie, and Helderberg Mountains in Albany County, New York.

### MYELODACTYLUS SCHUCHERTI, new species

Plate 5, figs. 9–9c.

Coil apparently of the close variety; circular part of stem long, and relatively thick. Cirri round, short, tapering, somewhat irregular in size, paired on successive columnals, which in the cirrus-bearing part are uniformly quadrangular, with straight sides. Crown unknown.

Diameter of coil as preserved about 15 mm. Length of main or crescentic portion of stem remaining about 40 mm.; length of columnals in that part average 0.5 mm.; width at place of fracture 4 mm., diminishing to 3 mm. in the curve next to the neck, and then to 2 mm. in the proximal neck, which, as far as preserved, is

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[12] Paleontology of New York, vol. 3, pl. 5, fig. 5; pl. 6, fig. 1.

[13] Idem, pl. 5, fig. 7.

20 mm. long. Columnals in circular neck average .17 mm. long, except where increased by coalescing to twice that length.

This species is of interest as giving us an additional Devonian representative. It is founded upon a single specimen, in excellent preservation as to some details, but unfortunately broken so that both the distal and proximal portions are wanting. The arrangement of cirri is upon the plan of *M. convolutus*, but they are relatively shorter and coarser. The most striking characters are the robustness of the proximal neck, which is about half the diameter of the main stem in the next adjoining coil, and the peculiar distribution of the columnals of which it is composed. These are extremely thin throughout, about .17 mm. on the outer side of the curve, but in the portion of the neck which is proximal to the calyx, they seem to become coalesced at either side so as to form for every two ossicles a single one of double their length. Thus in a side view the columnals here are about .35 mm. in length at the bottom, and when seen from the top one of the ossicles takes on a lenticular form. At some point between this part, which is that freely exposed in the figures, and that where the reversed curve begins, this doubling in length of columnals seems to disappear, so that it is not continuous for the whole of the neck. The ends of the enlarged columnals, and the form of the lenticular ossicle between them, have nearly the appearance of those in the variety *bijugicirrus*, but in fact they have no facets and bear no relation whatever to cirri. I am unable to give any explanation of this singular structure, which is a very definite one, as shown by the detailed drawings.

The species is named in honor of Prof. Charles Schuchert, by whom the unique type was collected many years ago in the course of researches upon the Helderbergian formations of Tennessee.

*Horizon and locality.*—Helderbergian, Linden formation; Benton county, Tennessee.

### AMMONICRINUS, new genus

Plate 6

Of the type of *Myelodactylus* in having the crown enveloped by a coiled bilateral stem; but without jointed cirri, their place being taken by unarticulated solid processes projecting from the two horns of the crescentic columnals; and with calyx of Camerate type.

*Genotype.*—*Ammonicrinus wanneri*, new species.

*Distribution.*—Middle Devonian; Eifel, Germany.

### AMMONICRINUS WANNERI, new species

Plate 6, figs. 4–6

I have proposed this genus and species upon the evidence of two very perfect specimens and some fragments from the Middle Devonian of the Eifel, which have been in my possession for many years, but hitherto undescribed because I was uncertain of their affinities. With the present study of this group it seemed probable that these curious fossils belonged here, although they resemble nothing in the crinoid line that has ever been seen before. Their superficial appearance is that of a coiled shell; but that idea was excluded by the fact that they have a jointed structure, and are built up of movable segments, coordinated by an axial nerve cord lodged in a canal which perforates the coil longitudinally, thus enabling it to open and close. Their systematic relation with the group now under consideration was definitely established when upon removing the projecting processes from the segments on one side there was disclosed the calyx of a crinoid tightly enveloped within the coil.

The extreme width of the segments forming the enclosing structure, in proportion to the diameter of the coil, seemed to preclude any analogy with the stem of a crinoid; but the facts as brought forth by the investigation show conclusively that it can not be anything else. They disclose a specialization which amounts almost to a freak, furnishing a fresh exemplification of the truth that in nature any modification of an organism may be expected which is not a mechanical impossibility.

A few measurements will show to what an extreme the modification in this form has gone. The coil is tightly closed in both specimens, with the distal end closely adherent and tapering rapidly to a point. It is more or less elliptic in both, with long and short diameters, respectively, of 18–22 and 15–16 mm. It is composed of relatively few segments, or columnals, which are of great width and thickness, and project on the perimeter of the curve in strong ridges, like cogs upon a wheel. In the smaller specimen there are 20 columnals on the exposed surface, a distance of about 50 mm., and in the larger one 24 columnals in a distance of 62 mm. Thus the columnals are about 2.5 mm. in thickness, or length longitudinal to the curve, at the exterior. In coils of *Myelodactylus ammonis* of like diameter there would be about 70 and 85 columnals for corresponding lengths of curve.

The width of the columnals is still more extraordinary as compared with those of any similar form. In the region of greatest width in the two specimens they are respectively 10 and 12 mm. wide. That is to say, this over-developed or hypertrophied coiled stem has a width exceeding half the diameter of the coil. We are accustomed to think of the stem of a crinoid as a much elongated structure, but here we have a stem of which the width is about one sixth of its possible length.

The most remarkable thing about the organism, however, is the marginal appendages, which occupy at either end of the segments the same position as the cirri in *Myelodactylus*. They are relatively of fair length, 5 to 11 mm., and somewhat irregular in shape, although mostly tapering to a point. Upon the most careful examination I am unable to find any sign of articulation, sutural division into cirrals, or of any organic structure; yet from the manner in which they overlap toward the center, these appendages must have had a certain amount of flexibility, to adapt themselves to the movements of the segments when inrolling. That there was ample facility for movement of this kind among the segments is clearly shown by their crenellated edges and strong beveling at the back in the two principal specimens, and by the presence of a fulcral ridge and fossae for muscles and ligaments as shown in the isolated ossicles. The axial nerve canal by which they are perforated extends to the last of the rapidly narrowing columnals, which are preserved in one specimen almost to the very end, and is also seen in the fragments.

It does not seem possible that articulations and intercirral sutures existing in life could have been completely obliterated in these fossils, which are unusually perfect and well preserved; but of course if the appendages should prove to be jointed structures the generic position might depend upon the calyx, as there would be no essential character discoverable to separate it by the stem alone from *Myelodactylus* or from *Camptocrinus.*

As to the crown, which has been partially exposed by cutting away the appendages at one side, I am unable to ascertain the details of its construction. The calyx is strong and thick, and probably belongs to the Camerata—perhaps to some form of the Hexacrinidae, which take on many strange modifications. There is a suggestion of *Arthracantha* in the remnants of calyx and arms which are seen.

In general form this species is to be compared with *Myelodactylus ammonis*, which has a similarly short coil, wide, and narrowly terminated, and in some specimens of which the maximum width of the stem is equal to one-third the diameter of the coil. Both were undoubtedly free, this one completely so, as it is hard to see how the apparently functionless appendages could have served for clinging to other objects.

From the little we can see of the crown, which bears no resemblance to that of the Heterocrinidae, there seems to be no reason to regard this strangely modified form as the end of the *Myelodactylus* series. My guess would be that it belongs to the Camerata, and might be regarded as the beginning of the *Camptocrinus* series. From the singular way in which the Carboniferous genus *Dichocrinus* adapts itself to some very broad modifications in the structure of stem, arms, and other appendages, it might reasonably be supposed that the prolific genus *Hexacrinus* among Devonian crinoids would do something of the same kind.[14]

This remarkable species is named in honor of Prof. Johannes Wanner, of the University of Bonn, an ardent student of the crinoids, whose works upon the Echinoderms of the island of Timor have brought to light one of the most extraordinary crinoidal faunas ever discovered.

*Horizon and locality.*—Middle Devonian, Eifel limestone; Prüm, Eifel, Germany.

### CAMPTOCRINUS Wachsmuth and Springer

Plates 7, 8

*Camptocrinus* WACHSMUTH and SPRINGER, North American Crinoidea Camerata, 1897, p. 779. Mississippian; Burlington to Chester.

*Camptocrinus* is simply a *Dichocrinus* with a coiled bilateral stem; or it might be called a *Myelodactylus* with a Camerate crown. It is the Carboniferous representative of the type under consideration. Whatever may have been the origin of this extreme stem modification, it developed independently in the two orders of the Crinoidea, without the slightest evidence of any evolutionary connection between the two genera in which it appeared, and then reappeared after the long time interval from the Lower Devonian to the Lower Carboniferous.

The genus *Dichocrinus* was peculiarly susceptible to secondary modifications upon a primitive type, and underwent a number of striking changes involving the stem and arms. The stem especially was in a plastic condition, yielding a variety of modifications in addition to that of the bilateral, coiled feature, which were not correlated with any material changes in the structure of the crown. Usually the stem is without cirri (pl. 11, fig. 4), but in some of the later forms ordinary cirri are present, in whorls along the greater part of the stem. I have some excellent specimens showing this. In one species the cirri are developed in numerous crowded whorls, limited to the upper part of the stem, and rising far beyond the height of the calyx and arms (pl. 11, fig. 7).

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[14] There is even some ground for suspecting that the mysterious *Edriocrinus* might be an offshoot from the Hexacrinidae. The calyx is fundamentally similar—five strong radials, with a large anal plate of similar form interposed in line with them. As it is now known to be a monocyclic crinoid with four basals (Springer, Crinoidea Flexibilia, 1920, p. 443), the analogy in this respect also is not so very remote. The Hexacrinidae include forms with two and with three basals, why not four? The secondary modification of the base by way of fused basals, often directly fixed without a stem, thought to be a result of reef life in shallow waters, reappears in different geological epochs down to the present time, in wholly unrelated forms; and there is no reason *a priori* why it may not have occurred independently in the Hexacrinidae.

The arrangement of columnals varies from uniformly short throughout to alternation with longer ones on different plans. The arms vary from 10, the usual number, to 20, 30, and 40; from uniserial to biserial; and from dichotomous to a heterotomous arrangement. They also in some species take on a recumbent habitus—a modification which occurs independently among the Rhodocrinidae, Melocrinidae, Batocrinidae and Platycrinidae. A reduction of primibrachs to a single small axillary plate forms the genus *Talarocrinus*, with the calyx elements otherwise similar to *Dichocrinus*, but with incipient changes in the tegmen by the enlargement of the axillary ambulacral, or radial dome plate, which when developed into huge wing-like processes produces the remarkable specialization of *Pterotocrinus.*

Finally the calyx itself begins to add a new element, in the form of additional rings of plates between basals and radials, leading to the extraordinary multiplication of such plates which we find in *Acrocrinus*, the latest survivor of the Camerata.

In the present form, owing to the more solid construction of the calyx and the simple character of the arms, there is no such irregularity or deformity as has been observed in *Myelodactylus*, only a slight distortion at the base due to pressure; and for the same reason the crown is more prominent and better exposed. Therefore it is found in perfect condition in several of the species, so that it may be fully inspected. Throughout the long geological range in which the genus persisted—from the Burlington to the later Chester—we find that the calyx has undergone little material change, and from that alone it will be difficult to differentiate some of the species. In all where the arms are known they are ten in number, and usualy uniserial, the brachials often passing into cuneate form, and perhaps interlocking toward the extremities.

But as in the Silurian type, the specialized stem offers good specific characters resulting from modifications upon a new plan. In all species, as before, the columnals in the proximal, rounded and noncirriferous region of the stem are very short and uniform; but beyond this, where the stem becomes elliptic, the columnals are of different lengths, parallel, and have marginal cirri at each end forming two rows along the inner or concave side of the stem. These usually spring from the suture between paired or doubled nodals, with one, two or three internodals interposed, each about the size of the combined nodal pair. No wedge-formed columnals have been observed. By far the most frequent plan is that of duplicate or triplicate cirri, of which the outer ones are borne upon facets at the junction of the nodal segments, forming clusters which diminish in size inwards. The cirrus-facet seems to lie directly above the suture.

The peculiar modification in stem structure which is manifested in the genus *Camptocrinus* is itself subject to some singular variations, of which one of the most striking seems to be connected with an effort toward resumption of the usual arrangement of cirri in whorls upon a rounded stem. This tendency is evidenced by the presence of incipient, immature, or rudimentary cirri, supplemental to those in the marginal rows, usually much dwarfed in size; they consist of a few small cirrals, often of only a single ossicle breaking through at the suture between the paired nodal segments, rounded off distally and without any axial canal through which further growth could be innervated. Rarely also it results in fully developed, fairly equal cirri in whorls of five, upon a stem which retains in part the elliptic section.

In this genus the form of the coiled stem differs considerably in transverse section from that of *Myelodactylus;* instead of being crescentic, with a decided concavity at the inner side as in the latter (pl. 1, fig. 6), it is here simply elliptic, with the curvature at the inner and outer sides almost alike, sometimes but little flattened and tending to become circular (pl. 8, various outline figures).

In this genus also the rounded proximal part of the stem, or neck, is usually materially shorter than in *Myelodactylus.*

*Distribution.*—Mississippian, Burlington to latest Chester; limited, so far as hitherto known, to North America, but now found to occur in the East Indies, in a formation claimed to be Permian.

### CAMPTOCRINUS PRAENUNTIUS, new species

Plate 7, fig. 1

Of large size; stem with broad open coil; round, slender, with reversed curvature in the proximal region, much enlarged in the middle region, and tapering to the distal end, where it begins to assume a bilateral form, with a few short cirri. Crown not closely enveloped by the stem; it is of the type of *Dichocrinus angustus*, with ten uniserial arms; apparently only a single primibrach, as long as the usual two.

This species from the Burlington limestone may be considered as the beginning of the modification leading to the fully developed *Camptocrinus.* It is the largest of the known species, the stem having a total length of 19 cm. In the great diminution of the otherwise thick stem in the proximal region, its reversed curvature, and the position of the crown in relation to it, the habitus of the species is thoroughly characteristic of the type; but it lacks the close envelopment of the crown by the stem and cirri, the stem being round for the greater part of its length. The cirri occur at the inner side of the curve only in the last 5 cm., where the columnals, which are of about equal length throughout, become slightly elliptic; they are small, not very regularly placed, but mostly on alternate columnals. The alternation of paired nodals with one or more large internodals, which is so marked a character in the later species, has not appeared in this one.

This form is exceedingly rare, not having been observed by any of the early collectors at Burlington—the fine specimen here illustrated and another imperfect one being the only examples among the numerous collections covering a period of over fifty years at that prolific locality.

*Horizon and locality.*—Mississippian, Upper Burlington limestone; Burlington, Iowa.

### CAMPTOCRINUS MYELODACTYLUS Wachsmuth and Springer

Plate 7, figs. 2–5*b*

*Camptocrinus myelodactylus* WACHSMUTH and SPRINGER, North American Crinoidea Camerata, 1897, p. 779, pl. 75, figs. 2*a* and 2*b* (not fig. 1).

Coil close in proximal region. Stem long, extending in the middle and distal portions into a broad curve, tapering to near the end; below the proximal neck, which is relatively short, it is composed of pairs of short columnals (nodals) bearing the cirri in marginal rows at each end, with a longer one (internodal) interposed between them equal in length to the two combined nodals. Cirri strong, rounded, rather long; composed of 15 to 20 diminishing cirrals, and tapering rapidly from their origin; they are doubled (or trebled) from each side of the paired nodals, springing from a large facet midway of the pair, with an additional facet or bifurcation following behind it. Thus there are along each margin at the concave side of the stem what appear to be duplicate cirri, separated by the interval of the longer internodal columnal. This is the way they usually appear in well preserved specimens; but actually there is frequently a third cirrus, and perhaps a fourth, each smaller than the one preceding, forming a cluster diminishing in size inward. The innermost cirri beyond the second are only to be seen after most careful preparation under a strong magnifier, being crowded inward and covered by the outer ones overlapping owing to the curvature of the stem. It was only after patient work, under exceptionally favorable conditions of preservation, that the facts were ascertained from which the sketches were composed by Mr. Chapman, showing the details of these structures in this and other species.

The exact mode of succession of these diminishing cirri is rather difficult to ascertain; the outer one rests in a good sized facet upon the suture between the two short nodals, and each succeeding one seems to be articulated upon the first cirral of its predecessor, somewhat as shown by the sketches on plate 7.

The occurrence of the cirri in diminishing clusters recalls the more elaborate arrangement seen in Bather's *Herpetocrinus flabellicirrus*. There is no sign of rudimentary cirri, outside of the marginal rows, in any of the specimens of this species. The crown is imperfectly known, being usually closely enveloped by the cirri, as is most of the species of *Myelodactylus*, but enough is exposed in one specimen to show that it belongs to the usual *Dichocrinus* type; it was evidently smaller than in the other Keokuk species. Total length of stem in maximum specimen 10.5 cm. with probably 1.5 cm. missing at the distal end; length of circular neck about 1 cm.; diameter of proximal coil in two specimens having the most complete stem about one-fourth the total length of stem.

In connection with the original description three specimens were figured, two of which are of the type above described; and it was from these two that the description relative to the details of stem and cirri was made, it being stated that the cirri were slender, composed of about sixteen to eighteen joints ending in a sharp point, and that they arose from alternate columnals—overlooking the fact that in the two specimens above mentioned the "alternate joint" is a pair of short columnals equaling in length the single one interposed.

The type locality is given as Indian Creek, Montgomery County, Indiana, and it is from there that the two specimens, together with three others subsequently acquired, were derived. In one of the latter the stem is preserved to nearly its full length, showing its broad and open curve (pl. 7, fig. 5). The original of Wachsmuth and Springer's figure 1 is from another locality and a somewhat higher horizon; it has a different arrangement of columnals and cirri—a form for which I have proposed the species *C. crawfordsvillensis*. While it is true that the description of the crown was made from this specimen, there is nothing substantially distinctive about it, and as in our present view the decisive specific characters in these forms are to be looked for in the stem, that fact may be disregarded.

In the character of multiple cirri springing from a pair of short columnals, this species takes on a plan which became the leading character in the later Carboniferous forms.

*Horizon and locality.*—Mississippian, Keokuk limestone, lower horizon; Indian Creek, Montgomery County, Indiana.

### CAMPTOCRINUS CRAWFORDSVILLENSIS, new species

Plate 8, figs. 1–3*e*

*Camptocrinus myelodactylus* WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, pl. 75, fig. 1 (not 2*a*, *b*).

Coil open, not closely enveloping the crown. Cirri doubled, or rarely trebled, as in the preceding species, or exceptionally single, and springing from a pair of short nodal columnals; but instead of these alternating with a single longer one, there are 2, 3, or exceptionally 4 internodals interposed between them, each about the size of the combined pair. The marginal cirri on either side are long and fairly stout, composed of 20 to 25 cirrals; and in addition to them there are, especially toward the distal end, remnants of smaller secondary cirri at the back of the same columnals, as if forming rudimentary whorls; where these appear the stem tends to lose its bilateral form and become round. This structure, occurring in a different horizon of the Keokuk from that of the last species, is constant in three specimens. The stem is not preserved to its full length in any of them, but extends well beyond the proximal coil. The calyx is that of the typical *Dichocrinus*, elongate with base one third the height of the cup. Arms two to the ray, composed of rather long, quadrangular ossicles. The crown is relatively larger than in the succeeding species.

*Horizon and locaity.*—Mississippian, Keokuk limestone, upper horizon; Crawfordsville, Montgomery County, Indiana.

### CAMPTOCRINUS PLENICIRRUS, new species

Plate 7, figs. 6, 6*a*

This species is proposed for a small specimen associated with the preceding which, while of the typical *Camptocrinus* type in the curvature, form and proportions of the stem and its elliptic section, has the cirri developed into complete whorls of five, nearly equal in size. In the arrangement of columnals, with paired short nodals and a single long internodal, it is like *C. myelodactylus*, but the cirri are distributed on a different plan; also it comes from a different horizon. From the other Crawfordsville species, last described, it differs in the single internodal, instead of two or more, and in the short, strongly tapering cirri not arranged in marginal rows. Unfortunately less than half the stem is preserved; if we had the whole of it, I have no doubt we should find it circular toward the distal end. The species represents a stage in the modifications of the type under consideration in which the cirri have resumed almost the distribution of those in a normal crinoid.

*Horizon and locality.*—Mississippian, Keokuk limestone, upper horizon; Crawfordsville, Indiana.

### CAMPTOCRINUS MULTICIRRUS, new species

Plate 8, figs. 4–9

*Camptocrinus cirrifer* WACHSMUTH and SPRINGER North Amer. Crin. Cam., 1897, pl. 76, fig. 13*c* (not 13*a*, *b*.).

Stem long, tapering almost to a point, becoming round and very slender at the distal end, but throughout the middle region strongly elliptic, and maintaining a nearly uniform width. Cirri doubled or in clusters of 3, diminishing inward; exceptionally single, springing from each end of pairs of short nodal columnals alternating with a long internodal as in *C. myelodactylus;* they are rounded, long and slender, composed when complete of upwards of 30 cirrals, mostly longer than wide. Besides the prominent marginal cirri in two rows at the concave side of the stem, additional cirri occur at the back in many places tending to form whorls; these secondary cirri are much smaller than the others and appear in a variety of rudimentary stages. Some have two, three or four cirrals; many have only the first cirral remaining, but pierced by the axial canal, indicating that one or more others followed; still others, rather numerous, have the first cirral imperfect with no axial canal, but rounded off like a terminal ossicle, as if it had just broken through without being able to grow farther. These details are fully shown by the instructive sketches made from the two remarkably perfect specimens figured on plate 8 (figs. 4, 4*a*, 6, 6*a*). The proximal circular neck is relatively short, and the crown is not closely enveloped by the cirri. The calyx is shorter than in *C. crawfordsvillensis*, especially the basal plates, which are not over one-fourth the height of the cup; they are frequently deformed owing to compression by the curved stem, so that they are shorter at one side than the other, as shown in figure 4 of plate 8. Arms two to the ray, uniserial with more or less cuneate ossicles; rather longer than is usual in *Dichocrinus.*

Dimensions of a maximum specimen: Total length of stem, 12.5 cm.; of circular neck 10 mm.; long diameter of columnal in middle portion 2.5 mm.; short diameter 1.5 mm.; diameter at circular neck 1 mm.; at distal end, rounded almost to a point, .5 mm.

This is the most abundant and widely distributed species of the genus, being represented in the collection by upwards of thirty specimens from two well separated areas, namely, that of Huntsville, Alabama, and of Monroe county, Illinois. It occurs in the lower part of the Chester, in the Ohara formation at Huntsville, and in what is regarded as its equivalent formation at the Illinois locality. Many of the specimens from both localities are beautifully preserved, having the stem to its full length, with the crown plainly showing through the thin fringe of delicate cirri, and sometimes completely isolated. The multiple arrangement of the cirri on alternating pairs of columnals is constant throughout all this material, except that in some specimens near the distal end the columnals tend to become more nearly equal in length, and the intervals between the cirri somewhat longer. I am figuring characteristic specimens from each of the localities. In none of them is there such a close, compact coil in the proximal region as occurs in *C. myelodactylus.*[15]

*Horizon and locality.*—Mississippian, lower part of Chester, Ohara and Renault formations; Huntsville, Alabama and Burksville, Monroe County, Illinois.

### CAMPTOCRINUS CIRRIFER Wachsmuth and Springer

Plate 8, figs. 10, 10*a*

*Camptocrinus cirrifer* WACHSMUTH AND SPRINGER, North American Crinoidea, Camerata, 1897, p. 780, pl. 76, figs. 13*a*, *b* (not 13*c*).

Like *C. multicirrus*, except that the cirri are more attenuate, and there is a tendency of the pairs of short columnals bearing the multiple cirri to coalesce so as to resemble a single ossicle; also in some specimens the rudimentary cirri toward the distal end tend to form rather well defined whorls associated with a more rounded stem, which may well mark the end of the specialization by which this whole type is characterized.

This species occurs in the upper part of the Chester, the Glen Dean formation, the fauna of which is sharply distinguished from that of the preceding species. The differences from that species are very slight, and if the two occurred in the same formation might well be disregarded. But in view of the changes which took place in other genera of the echinoderms during the considerable time interval between the respective formations, it seems best to recognize the modifications, however slight they may appear in the fossils, as indicating a definite specific change.

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[15] *Camptocrinus indoaustralicus* Wanner.

Die Permischen Krinoiden von Timor, vol. 2, 1924, p. 81, pl. 3, figs. 9–11. This species, the description of which appeared subsequent to the preparation of the text hereof, adds another to the strictly Lower Carboniferous types which have been found associated with the remarkable Permian fauna of the East Indies. The author notes its great similarity to *C. cirrifer*, from which he says a separation is scarcely possible by the characters of the calyx and arms, but he thinks the structure of the stem offers sufficient differences to justify a new species. But the similarity is even greater than he thought, when comparison is made with the form of *C. cirrifer* now separated under *C. multicirrus*. For the stem character upon which he mainly relies, namely, two short ossicles alternating with one longer, is most conspicuous in our species; and the "small knots" which he mentions as occurring along the suture line between the short pair are the remains of budding cirri as above described.

Wachsmuth and Springer's figure 13*c*, although not very characteristic, must go with *C. multicirrus* in conformity with the horizon from which the specimen is derived.

The extreme tenuity of the cirri in this species is constant in several specimens, in which they often contain as many as forty narrow cirrals, which are longer than wide.

*Horizon and locality.*—Mississippian, upper part of the Chester, Glen Dean formation; chiefly at Sloan's Valley, Pulaski County, Kentucky, but also at Newman's Ridge, Bland County, Virginia.

## THE RECUMBENT ARMS

Among existing crinoids those taken by the dredge or otherwise captured have been found with their arms, when preserved, either outstretched or folded together. On the sea bottom, in the case of stalked crinoids, both positions may be assumed, depending upon whether the crinoid 1, was seeking food, in which case the arms would be spread so as to bring the maximum of surface on the ventral side into contact with the water containing the organisms upon which the crinoid feeds, or 2, was in a state of rest, in which case the arms would probably be folded as a matter of protection to the vital organs. Which attitude was most frequent, or longest continued, we have no means of knowing, but among the specimens as taken out of the water both conditions are found. When disturbed by the dredge or tangles, many individuals respond to the contact by opening the arms widely, while others seem to bring them close together, and still others cast them off.

Among fossil crinoids the second was undoubtedly the most frequent occurrence, for practically nine out of every ten well preserved specimens, deposited so as to become imbedded in soft material, have the arms folded. And in certain large groups, such as the Flexibilia, they are scarcely ever found in any other condition. Therefore it is to be assumed that such was the usual position of the fossil crinoids at death. Any other disposition of the arms by which they become so firmly retracted as to remain fixed in that position after death, and to become fossilized in it, must therefore be associated with some structural modification in the articulation of the arms by which their motion in an upward direction would be restricted. Many instances have been observed in which this is apparently the case, and in which the facts are not explained by supposing that the recumbent arms were due merely to casual movements by the animal, voluntary or involuntary. It is evident that the mechanics of the arm structure was such that the motion of the arms upon their hinges was downward rather than upward, and that the pendent position, with the dorsal side of the arms pressing backward upon the calyx and stem, was the position of rest, or of greatest fixity. Then the arms, instead of opening out from the top in order to extend themselves and their pinnules for the maximum of contact with the water, would be extended from the bottom, the ventral side containing the food grooves being already in position for complete connection with the currents by means of the pinnules and their softer appendages.

The proof of this is found in the fact that in numerous instances the marks of long continued pressure by the arms in habitual positions are found upon the outer wall of the calyx and the stem, producing permanent indentations which could not have occurred unless the arms had become fixed in that position (pls. 9, fig. 9; 18, fig. 4).

In the most conspicuous cases of this kind I have observed that the recumbent arms are always profusely provided with long and thickly studded pinnules, and these, standing out from the curving surface of the reversed arms, have all the food-gathering exposure that they could obtain in any other way.

It is also worth noting that the entire group Flexiblia, in which the arms are almost invariably found folded together in the fossil state, and in which recumbent arms are unknown, are destitute of pinnules.

Neither are the recumbent arms, of the type which I am about to describe, found among the Inadunata, whether with pinnules or without; and regardless of the matter of pinnules it is probable that the mechanics of the arm joint, both in the Flexibilia and the Inadunata, precluded the possibility of any such backward and downward motion as would be required for the arms to become settled in that position.

While it is true that among the Recent crinoids specimens brought up by the dredge frequently have the arms curved backwards upon the stem, leaving the oral surface open except for its forest of pinnules, this is merely one phase of arm movement in the natural and usual condition, due to their enormous flexibility. There is not that complete reversal in the habitus of the arm which makes it hang downward as if suspended from the roof of the calyx. For that the solid dome of the Camerata is needed to afford a firm anchorage for the suspended arms, often projecting as it does at the edge of the tegmen out over the dorsal wall below it, and at all events furnishing a rigid means of support. In typical examples to be mentioned the covering plates of adjacent arms are for quite a distance suturally connected, thus preventing the usual motion of the arms.

It is only among the Camerata that such a well supported hinge is found; and here the structure occurs in several of its families, occasionally, as an independent modification, and in otherwise unrelated forms; specifically distinct, and sufficiently rare to fall within our category of "unusual forms." It is not even a generic character.

Hitherto the recumbent type of arms has been observed among the following families and genera of the Camerata:

Family Rhodocrinidae, genus *Gilbertsocrinus.*
Family Batocrinidae, genus *Barrandeocrinus.*
Family Platycrinidae, genus *Eucladocrinus.*
Family Hexacrinidae, genus *Dichocrinus.*
Family Hexacrinidae, genus *Acrocrinus.*

I have now to add a remarkable new species of *Macrostylocrinus* among the Melocrinidae, and another of the typical *Platycrinus.*

The oldest example now known, and one of the most characteristic, of this type of arms is *Barrandeocrinus* from the Silurian of the island of Gotland—a form with the calyx of the Batocrinidae. It exhibits the extreme compactness of the curtain of arms as they press firmly against the calyx and stem, leaving distinct impressions due to the protracted pressure, as is shown by the beautiful figure drawn by Mr. Liljevall from one of the specimens in the Stockholm Museum, published by Wachsmuth and Springer in the North American Crinoidea Camerata (pl. 8, fig. 1), and reproduced herein, as plate 9, figure 6, and by another from a specimen of my own, figure 7, showing the calyx completely enveloped by the arms.

The next in order was a holdover from the Silurian, which did not take on the recumbent arm structure until it reappeared under a new species in the Devonian, which will now be described.

## Genus MACROSTYLOCRINUS Hall

*Macrostylocrinus* Hall, Pal. New York, vol. 2, 1852, p. 203.
Silurian to Devonian.

### MACROSTYLOCRINUS RECUMBENS, new species

Plate 9, figs. 1–4

The genus *Macrostylocrinus* Hall, of the family Melocrinidae, is diagnosed by Wachsmuth and Springer[16] substantially as follows:

> Monocyclic. Lower brachials, with well defined interbrachials between them, forming a part of the dorsal cup. Radials in contact all around. Basals three, unequal. Interbrachials few. Anal area much the widest, and quite distinct; three plates in the first range, the middle one large, supported by the sloping shoulders of the two posterior radials, and flanked by a smaller one at either side which, together with the first primibrach, rests upon the upper face of the radial; the middle or anal plate is usually followed by one or two other anals, longitudinally arranged. Radials very large, their upper

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[16] North American Crinoidea Camerata, 1897, p. 285.

**corners but slightly truncated by the interbrachials. Arms usually ten, long, biserial, simple throughout. Tegmen low, composed of numerous irregular plates.**

The genus stands out distinctly from all the other Melocrinidae by having three basals, and in the anal interradius three plates in the first range above the closed radial ring, instead of only one. The form is typically Silurian, six species having thus far been recognized, of which two are from the Rochester shale, three from the Waldron, and one from the Louisville limestone. The specimens of these species are rather small. The arms, so far as known, are two to the ray, rather heavy, and of the normal type.

When the remarkable Devonian material upon which the present species is described was first seen, its generic affinities were not apparent, because the calyx was completely enveloped in the downward hanging arms, and its composition was thereby hidden; there was no thought of its belonging to a form of which the superficial appearance was so widely different. It was only after removing part of the arms from two specimens that I was able to determine the essential elements which fixed its position as now recognized. Comparison of the two figures on plate 9 with the foregoing statement of generic characters leaves not the slighest doubt that we have here a well marked representative of *Macrostylocrinus*, which on passing over from the Silurian to the Devonian has undergone some striking changes.

The outstanding difference from all previously described species lies in the number of arms, and their recumbent habitus. Instead of being limited to 10, the arms occur in clusters of 5 to the ray, perhaps 4 in two of them, given a total of 23 to 25 arms, the bifurcations being indicated in the tegmen by nodose axillary ambulacrals. The mode of articulation is such that their facets are directed downwards from underneath a projection, or overhang, from the edge of the tegmen, which is thus broader by at least a fourth than the calyx at the arm bases. Accordingly the tegmen is left free and clear as a smooth roof, and the arms, heavy and closely apposed, form a closed fringe or curtain about the calyx, meeting by their distal ends around the stem, and having their outer sides thickly studded with strong pinnules. They do not, however, in this species press closely against the calyx wall so as to leave indentations, as in some other forms, but there is an open space between the calyx and the dorsal side of the arms, so that in case of fracture in the region of the arm bases the calyx may come loose and separate freely from the curtain of arms which surrounds it, as actually happened with the two largest specimens.

In the series of specimens obtained there are 14 individuals, and in all of them, without a single exception, the arms are firmly and regularly fixed in the position above described—a fact which seems to warrant the conclusion that this habitus is associated with a definite structure, and is not a temporary condition due to casual movements of highly flexible appendages.

As to minor details: The anal series is strongly developed in this species, forming a more prominent ridge than usual in the Silurian species, being especially conspicuous when seen from the tegmen. The stem is constructed of very short columnals, one of which projects at intervals of five or six, with a beaded perimeter.

In point of size, this species presents a wide difference from all the others, which, as stated, are usually small, the largest, and latest in age, *M. meeki* Lyon, of the later Niagaran, having the calyx 20 mm. high and 22 mm. wide at the arm bases; whereas our two specimens with the calyx exposed are about 25 mm. high and 25 mm. wide at the arm bases. Measured from the surface of the tegmen to the distal end of the pendent arms where they close around the stem, and in width over all at the outside of the pinnules, these dimensions are about 35 mm. and 32 mm. respectively. In figure 1, and in two other specimens not figured, the same measurements give 40 mm. in height and 37 mm. in width.

But this by no means represents the maximum dimensions of the species, for among the 14 specimens, all from the same layer and locality, are two from which the calyx, including tegmen and arm bases, is broken away, that were more than three times as large. Only the hollow shell remains, containing the closely apposed arms from an irregular fractured edge below the arm bases to the distal end. That much of the crown is 12.5 cm. high and 7.5 cm. wide. Inasmuch as one-seventh of the individuals attain this great size, it is clear that the optimum for this species is far beyond that for any of the Silurian forms.

*Horizon and locality.*—Lower Devonian, Oriskany; Cumberland, Maryland. The specimens occur in a friable calcareous sandstone, associated with *Edriocrinus*, *Technocrinus*, and numerous other forms peculiar to that horizon. The fossils as found have been leached by the percolation of water, carrying away the calcareous material, and partially replacing it by silica. By this leaching the finer surface markings have been obliterated. The series of specimens under consideration are part of a large collection made by Frank Hartley and acquired by me many years ago; but they have remained undescribed until now for want of time.

Some other occurrences of this nature, not all new species, which should be further illustrated, will be here discussed.

### Genus GILBERTSOCRINUS Phillips

Devonian to Keokuk.

#### GILBERTSOCRINUS DISPANSUS Wachsmuth and Springer

Plate 10, fig. 1

*Gilbertsocrinus dispansus* WACHSMUTH and SPRINGER, North Amer. Crin-Cam., 1897, p. 233.

In most of the species of this genus in which the arms are known they tend to hang downward over the cup, emerging beneath an overhang at the edge of the tegmen. One of the species in which the arms are not pendent, *G. tuberculatus* of the Burlington limestone, is so closely similar to one of the same formation in which they are that the two can scarcely be differentiated by other characters. In a species from the Keokuk limestone of Indiana, *G. dispansus*[17] it now appears from specimens obtained since the description was made that sometimes the arms, which are extremely long and slender, after extending downward for a part of their length bend backward upon themselves and are directed upward toward the tegmen, with the result that the ambulacral furrows and pinnules in one part of the arm appear to be upon the outside, and in another upon the inside (pl. 10, fig. 1). It is rare to find these two conditions completely shown in one specimen, as is fortunately the case in the one I have figured; and their presence separately in different specimens has led to some curious theories touching the properties of arms peculiar to this crinoid. This was probably the occasion of the erroneous figure by Meek and Worthen in the second volume of the Geological Survey of Illinois (p. 220), in which the arms are pictured as recumbent over the dorsal cup, but with the ventral side underneath, and as to which the authors say, on page 221:

> In the above cut the minute true arms of the typical species of *Goniasteroidocrinus* are seen to branch so as to form nine to each ray. The cut shows only their outside, on which we have seen no indications of ambulacral furrows; these may have been obliterated in cleaning the specimen, or possibly they may present the anomalous character of being on the *under side* and thus differ from those of all other known crinoids.

*Horizon and locality.*—Mississippian, Keokuk limestone, lower horizon; Indian Creek, Indiana.

### Genus PLATYCRINUS Miller

Devonian through Lower Carboniferous.

#### PLATYCRINUS PENDENS Wachsmuth and Springer

Plate 9, figs. 5, 5*a*

*Platycrinus pendens* WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 647.

Among the vast number of species of *Platycrinus* which were treated by Wachsmuth and Springer in the Camerata Monograph, there were none which showed any indication of recumbent arms. In the closely related *Eucladocrinus* the long radial extensions, or tubular appendages, frequently show a tendency to bend backward over the calyx, but always the true arms are folded over the ventral side; even in cases like that of *E. tuberosus*[18], where the tegmen is strongly hemispherical, and the arm bases are directed far below the horizontal, the arms fold in the normal way. The same thing may be said of other genera with hemispheric calyx, like *Megistocrinus*, *Agaricocrinus*, etc.

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[17] Wachsmuth and Springer, N. A. Crin. Cam., p. 240, pl. 15, figs. 2*a*–*d*.

In recent years, however, I have obtained two specimens of *Platycrinus* from the well known locality of Le Grand, Iowa, but at a different horizon from that of the numerous species heretofore described, in which the arms are compactly folded backward upon the calyx and stem, and apparently fixed in that position, after the manner of *Barrandeocrinus* and *Acrocrinus*. The calyx in both is completely enveloped, and can only be partially exposed, considerably distorted, in one of them. We know that the species belongs to *Platycrinus*, because both specimens have the twisted, elliptic stem. Of other characters little can be said, and the position of the arms must distinguish the species. I am giving two views of one specimen; the other is slightly larger, and equally characteristic as to the arms.

*Horizon and locality.*—Mississippian, Kinderhook group, lower horizon; Le Grand, Iowa.

### Genus DICHOCRINUS Münster

Plate 11

*Dichocrinus* Wachsmuth and Springer, North Amer. Crin. Cam., 1897, p. 753.

Lower Carboniferous, Kinderhook to Chester.

Among the changes to which this highly variable genus and its allies were subject, the recumbent arm took a strong hold. This was illustrated by Wachsmuth and Springer under their species *Dichocrinus pendens* from the Burlington limestone[19], and I am now giving some additional figures of it, including one of a specimen with the complete stem and crown, partly to show the persistence of this character, several specimens having now been found, and partly to exhibit the *Dichocrinus* stem as usually seen, in comparison with one of its remarkable variations (pl. 11, figs. 4, 7). The first is without cirri, except in the form of distal root branches, while the latter has cirri in regular whorls, beginning in the upper region of the stem, of such an extraordinary length that they completely envelop the calyx, and probably the arms, which are broken off. While there is no trace either of coiling or bilateralism, yet the peculiar behavior of the cirri in this specimen should be considered in connection with what was later developed under *Camptocrinus*.

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[18] North Amer. Crin. Cam., pl. 72, figs. 4*a*, 6*c*.

[19] Idem, p. 774, pl. 78, fig. 15.

Wachsmuth and Springer at the same time described from the Warsaw group another species, *Dichocrinus oblongus*[20], founded upon a unique specimen having only the calyx preserved. Specimens subsequently obtained with the arms attached show that these are of the recumbent variety, and I am accordingly illustrating the species anew (pl. 11, figs. 5, 6).

In these two species, however, as I see them now, there does not seem to be quite the same structural type, or mode of attachment of the arms, that we have in the preceding examples. The arms are not so compactly placed, nor connected in the tegmen by their covering plates, and their appearance seems more like that of ordinary bending backward as the result of great flexibility.

### Genus ACROCRINUS Yandell

Plates 9, 12, and 18

*Acrocrinus* YANDELL, Amer. Journ. Sci. and Arts, vol. 20, 1855, p. 135.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 805.—BATHER, Lankester Zoology, pt. 3, 1900, p. 159.

Carboniferous, Burlington to Pennsylvanian.

Of a very different character from those last mentioned are the arms of *Acrocrinus*, the last successor in the family Hexacrinidae, which is thoroughly illustrated in the Camerata monograph (pl. 80). In this form we have in one species a perfect example of the recumbent arm structure as I have described it, in which not only are the arms compactly placed, in close contact, connected in the tegmen so as to restrict motion, directed downward from the edge of the tegmen and closing around the stem, but the calyx is marked by numerous longitudinal impressions following the course of the arms and formed by the continued pressure of the arms from their dorsal side. I think there is no doubt that they grew in that way, and that the mode of life of this species was to have the arms completely recurved with the pinnules on the outside.

The species in which the recumbent arm occurs, *Acrocrinus amphora* Wachsmuth and Springer, came from a single colony at Huntsville, Alabama, in the Ohara formation of the lower Chester (formerly referred to the St. Louis), in which it was fairly abundant. Upwards of sixty specimens were collected by Wachsmuth, and with one or two imperfect exceptions the structure as above set forth is constant throughout. But this does not apply to the type species, *A. shumardi*, which is from a higher horizon, the Glen Dean formation of the upper Chester; of this five specimens are known, and in every one of them the arms are erect, and there is no sign of indentations upon the calyx, while the species is well characterized otherwise by the less height and greater width of the radial plates.

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[20] North Amer. Crin. Cam., p. 759, pl. 78, fig. 9.

Therefore it must be conceded that while this specialization has nothing to do with the genus as a controlling character, since in five of the genera in which it occurs both types of arms are found, it does hold good for the species.

While reference should be had to the ample illustrations given by Wachsmuth and Springer on plate 80 of the Camerata monograph, some of which I reproduce, I am for convenience giving some additional figures, especially a new one of the rarer species, *A. shumardi.*

## ADDITIONAL ELEMENTS IN THE CALYX

In connection with the genera last above discussed, another singular modification is to be considered.

As before stated, the dorsal cup of a crinoid consists primarily of a circlet of radials supporting the arms, and one or two rings of basals below them, plus interradial structures if present. While the latter may or may not be present, and when present are regarded as secondary elements which exhibit a wide range of variation in form and number, any departure from the normal two, or three, rings of primary plates has been considered as extremely exceptional. Therefore the occurrence of numerous additional sets or series of plates between the radial and basal circlets in *Acrocrinus*, the last survivor of the Camerata, has been regarded as a structure *sui generis*, appearing suddenly at the end of the series, as a reversion to their cystid ancestry.

While such a multiplication of plates is not uncommon among the irregular, many-plated cystid types, the definite insertion of an extra ring of primary plates in a form of otherwise regular construction is to be noted in the Ordovician genus *Macrocystella*, thus producing a dorsal cup of 4 rings of plates. This modification was not followed up in either of the orders of the crinoids. But it is now of interest to note that the extensive development of such additional plates in *Acrocrinus* is not the sudden occurrence that we have hitherto supposed, but is the culmination of one of the several remarkable modifications that took place in the generic types represented by *Dichocrinus* and its derivitives. As evidence of this fact I am able to offer well-marked specimens of two species from widely different horizons.

### ACROCRINUS PRAECURSOR, new species

Plate 12, fig. 1

I have given this name to an isolated specimen from the Burlington limestone consisting of the calyx and part of the cuneate arms, somewhat displaced, at first supposed to be merely an abnormal *Dichocrinus*. The bisected base and the radials with the interposed anal plate are distinct, and in good condition. Between these two primitive rings of plates is interpolated a wide band of supplementary pieces occupying more than half the total height of the dorsal cup. Those next to the radials are more than half their size, and form a ring alternating with them; from there down to the basals the plates diminish rapidly in size, and the alternation becomes irregular, but represents the equivalent of at least three additional rings of plates. The smaller size of the lower plates would indicate that they were the latest formed. The anal plate, which is fully as large as the radials, is succeeded downward by a diminishing vertical series of three plates in line with the interbasal suture.

As compared with species of *Dichocrinus* in the same formation the radials are very much shorter, the space which they ordinarily occupy being in part taken by the anomalous additional plates. As the relative height of the radials becomes important, the following measurements of the type specimen may be noted: total height of calyx 9 mm.; of radials 2.5 mm.; of basals 1.5 mm.; of band of supplementary plates 5 mm. Thus the radials occupy 27 per cent of the height of the cup; whereas in four of the principal species of *Dichocrinus* of the Upper Burlington limestone the radials constitute from 60 to 66 per cent of the height of the cup; and in no other species from any formation do they occupy less than 50 per cent. In other words, these are not the radials of *Dichocrinus*. The arms, ten in number, and relatively slender, are somewhat displaced in the fossil, and those which appear directly above the anal series do not belong there.

From the fact that no such a specimen has ever been seen before in all the numerous collections made at Burlington during more than half a century, it might be suggested that this is a mere sporadic occurrence. And perhaps it is. Nevertheless it is a definite structure, foreshadowing one of the most remarkable derivatives of *Dichocrinus*, and containing all its essential characters; therefore a place for it must be found. The question is whether to call it a delayed *Dichocrinus* or a premature *Acrocrinus?* This question has in fact been answered in advance; for just such a contingency as is here presented was provided for by Wachsmuth and Springer in the Camerata Monograph, when in discussing these genera we said on page 804:

The introduction of a narrow belt of supplementary pieces between the basals and radials would be sufficient to transform any *Dichocrinus* into an *Acrocrinus*.

When along with this is correlated the further fact that the radials in this form, by reason of their extreme relative shortness, are not the radials of *Dichocrinus* but of *Acrocrinus*, the conclusion logically follows that it is best placed under the latter genus.

This means that the tendency to this new specialization by way of multiplication of calyx plates began earlier than has been supposed; and it will be shown by the next following species that its development to the extreme stage attained by the typical *Acrocrinus* was by a further gradual process.

It may be here observed that along with all these various derivatives of *Dichocrinus* the strong parent genus continued to carry on to the end of the lower Carboniferous, where it is represented by a well defined species, *D. superstes*, occurring in the latest formation of the Chester. The only one that survived it was *Acrocrinus*, which held over into the Coal Measures with a degenerate species having only six bands of supplementary plates, actually less like the typical form than is the species just described.

*Horizon and locality.*—Mississippian, Upper Burlington limestone; Burlington, Iowa.

### ACROCRINUS INTERMEDIUS, new species

Plate 12, figs. 2–5

In this species, presenting a further immature or rudimentary stage of the genus, we are not obliged to rely upon an isolated individual, but are fortunate in the possession of a series of excellent specimens from a single colony, by which all the characters of this type are thoroughly illustrated. They were found by Frederick Braun while collecting for me in the season of 1913[21] in Monroe County, Illinois, as a part of a considerable colony of well preserved crinoids from a formation in the lower part of the Chester now designated by the Geological Survey of Illinois as the Renault formation.

The material consists of two nearly complete specimens, with arms and stem well preserved, and two calices which contribute important information. All agree in having a band of supplementary plates, of either two or of three rings, which diminish downwards, intercalated between the bisected base and the radials; the plates of the successive rings above the basals alternate regularly except at the posterior side, where there is a vertical series below the anal. Above the anal plate, and back from the edge, is a pyramid of small plates marking an opening through the tegmen. As in the preceding species, the radials are relatively short, their average height in the four specimens being 32 per cent out of a total of 6 to 7 mm. The calyx is well elongated and conical, with curved sides; height to width at the top being as 1.5 to 1, and at the base as 1.5 to .27. The species is small, the four specimens varying but little from 6 mm. in height of cup.

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[21] Explorations and Fieldwork of the Smithsonian Institution in 1913. Smithson. Misc. Coll., vol. 63, no. 8, pp. 14–16.

The arms are relatively strong, biserial, erect, and closely fringed with long pinnules. The stem is composed of rounded, nearly equal columnals, about half as long as wide, increasing somewhat in width distally; this is not so evident in one of the figures because not well exposed in the matrix.

The striking feature of this series of specimens is the extreme regularity of their construction, with the single exception of the number of ranges of the supplementary plates; two of the specimens having two ranges, one three, and the fourth, which is considerably crushed, apparently has partly both. Thus the addition of the inserted plates is a definite structure, somewhat plastic, heralding their great development to the twenty circlets of the typical *Acrocrinus*. Presumably the new species preceded the latter in time, but our knowledge of the stratigraphy of their occurrence is not sufficiently minute to furnish the proof of it. *A. shumardi*, from the Glen Dean formation of the Upper Chester, is, of course, later than the present species. *A. amphora*, from the Ohara formation, may be of approximately equivalent age; both of these species being from a different region. But there is a third very rare species, *A. urnaeformis*, in the same mature stage, described by Hall from the same region in Illinois as our species,[22] of which there can be no doubt, as I found a well marked specimen of it in the same layer which produced the types herein described; so that while the matured form continued into the later formations, with our present knowledge it must be considered that both forms existed together at one period.

As a result of the facts brought out under the last two heads, we have in the concurrent development in the genus *Dichocrinus* and its derivatives of two such striking characters as the recumbent arms and an added calyx element, a remarkable example of long preparation for an eventual culmination which is to mark the extinction of the order to which it belongs.

*Horizon and locality*.—Mississippian, lower Chester, Renault formation; Burksville, Monroe County, Illinois.

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[22] Geol. Iowa, pt. 2, 1858, p. 690, pl. 25, figs. 11*a*, *b*.

The following species are also illustrated for comparison:

### ACROCRINUS SHUMARDI Yandell

Plate 12, figs 6, 7

*Acrocrinus shumardi* YANDELL, Amer. Journ. Sci., vol. 20, 1855, p. 135.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 806, pl. 80, figs. 1–3.

Upper Chester, Glen Dean formation; Grayson County, Kentucky.

### ACROCRINUS AMPHORA Wachsmuth and Springer

Plates 9, figs. 8, 9; plate 12, figs. 8, 9; plate 18, fig. 4

*Acrocrinus amphora* WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 808, pl. 80, figs. 4–9.

Lower Chester, Ohara formation; Huntsville, Alabama.

### ACROCRINUS WORTHENI Wachsmuth

Plate 12, fig. 10

*Acrocrinus wortheni* WACHSMUTH, Geol. Surv. Illinois, vol. 7, 1882, p. 343, pl. 30, fig. 13.—WACHSMUTH and SPRINGER, N. A. Crin. Cam.. 1897, p. 807, pl. 80, figs. 10*a*, *b*.

Coal Measures; Peoria County, Illinois.

## THE WING-LIKE RADIAL PROCESSES

There still remains to point out another line of productive modification furnished by this fertile genus *Dichocrinus*, leading to a specialization of an entirely different type. In this the major development takes place in the tegmen, at the expense of the arms and the dorsal cup. The arms become short and relatively inconspicuous; the radials small and no longer dominating the cup; the two fair-sized primibrachs of the parent genus have been reduced to a single minute triangular piece, which is often invisible; the large anal plate, which was of similar form and size to the radials, is now a pentangular or more or less wedge-formed piece, narrowing upward, sometimes to an apex below the level of the radials. The chief developmental activity of the skeleton is concentrated in the ambulacral region of the tegmen, where the axillary plate, or radial dome plate, is hypertrophied into a variety of forms, some thin and knife-like; some thick, rounded, club-shaped, or spatulate; and still others bifurcating, until there is produced the wing-like processes of *Pterotocrinus*, structures unlike those seen in any other crinoid. They are analogous to the spines of *Dorycrinus*, but far more specialized and complex; their different forms are shown upon plate 79 of the Camerata monograph.

The essential calyx elements of *Pterotocrinus* are the same as those of *Dichocrinus*, namely, two basals, a ring of radials, and an anal plate in line with them. The line of succession between them through the genus *Talarocrinus*, as was stated by Wachsmuth and Springer when proposing it, is plain and evident. It is intermediate in structure, and partly so in time. While *Dichocrinus* carries its strong and simple calyx through from the Kinderhook to the end of the Lower Carboniferous, *Talarocrinus* as one of its off-shoots begins with an isolated species in the Warsaw, and develops mainly in the lower Chester; and *Pterotocrinus*, although first occurring in one of the lower formations of the Chester, is characteristically a genus of the upper Chester. *Talarocrinus* was short lived, sharply limited in time, and is found by the geologists to be an excellent horizon marker. (See pls. 13, 14.)

*Talarocrinus* has the same basals, radials, and anal plate as *Dichocrinus*, but drops one primibrach, retaining a small triangular axillary. In *Pterotocrinus* the minute primibrach, sometimes invisible, is followed by single secundibrachs, also axillary, which often together with the outer tertibrachs rest almost horizontally within the radial facet and are suturally connected with it, so that the ray to that extent is not free, but is incorporated in the dorsal cup. The *Talarocrinus* tegmen enlarges with a variety of more or less tumid plates, among which the axillary ambulacral especially begins to develop into prominence, from low convex to sharp, nodose or spiniferous (pl. 13, figs. 1–15; pl. 14, fig. 6). Not all of these plates are so modified; among several hundred well preserved specimens in which the general tendency can be observed, it appears that about half of them are distinctly enlarged. Some of these are shown by figures on plate 78 of the Camerata mongraph, and the genus has also been extensively illustrated by Ulrich[23] and by Weller,[24] from whose figures the many variations can be studied in detail.

The modified ambulacral in *Pterotocrinus* is seated in a distinct facet, from which it sometimes falls out (pl. 13, fig. 20), and the same thing occurs in *Talarocrinus* (pl. 13, fig. 13). Along with these tendencies, it is now further instructive to see that occasionally in *Talarocrinus* the anal plate is reduced to the acuminate piece of *Pterotocrinus* (pl. 13, fig. 5).

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[23] Mississippian formations of western Kentucky, 1917, pls. 8, 9, 10.

[24] Illinois State Geol. Surv. Bulletin 41, 1920, pl. 6.

## Genus PTEROTOCRINUS Lyon and Casseday

Plates 13, 14

*Asterocrinus* LYON, Geol. Rep. Kentucky, vol. 3, 1857, p. 472.—*Pterotocrinus* LYON and CASSEDAY, Amer. Journ. Sci. and Arts, vol. 29, 1860, p. 68.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 2, 1881, p. 87; North Amer. Crin. Cam., 1897, p. 791.
Mississippian, Upper Chester.

This genus was proposed by Lyon under the name *Asterocrinus* with two species, *A. capitalis* and *A. coronarius*, which being preoccupied was afterwards changed by Lyon and Casseday to *Pterotocrinus*, and three new species described. The several species are illustrated by Wachsmuth and Springer;[25] but I am adding some new figures, 1, to illustrate a species of Lyon and Casseday that was never figured; 2, to clarify the account of the most remarkable of all the species, not hitherto understood for lack of proper illustration; and 3, to give along with them a good representation of the other leading species.

### PTEROTOCRINUS RUGOSUS Lyon and Casseday

Plate 13, figs. 17–20

*Pterotocrinus rugosus* LYON and CASSEDAY, Amer. Journ. Sci. and Arts, vol. 29, 1860, p. 71.

The description, unaccompanied by any figure, is as follows:

> The condition of our specimen is such that a particular description can not be made; the arrangement of the parts, however, is evidently quite similar to that of *P. depressus*. The basals, first, second, and third radials are present, together with parts of the wings and a portion of one of the arms. This species differs remarkably from *P. depressus* in the greater thickness of the pieces, prominence of the base, the knobby protuberances upon it and upon the first radials, the depth of the columnar pit, as well as by its roughness and more robust appearance.

This species was founded upon a "single crushed and imperfect specimen," which I am now figuring after being developed by further preparation, together with three other calices which confirm the description very clearly. This new material shows that instead of being conspecific with *Pt. acutus*, as Wachsmuth and Springer[26] thought it might be, this form is a very well marked variation of the type of *Pt. depressus*, from which it is distinguishable, as the authors pointed out, by the characters of the base.

*Horizon and locality.*—Mississippian, Upper Chester, Glen Dean formation; Falls of Rough Creek, Breckinridge County, Kentucky.

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[25] North Amer. Crin. Cam., 1897, p. 79.

[26] Idem, p. 801.

### PTEROTOCRINUS CORONARIUS Lyon

Plate 14, figs. 1–3*a*

*Asterocrinus* (?) *coronarius* LYON, Geol. Surv. Kentucky, vol. 3, 1857, p. 476, pl. 1, figs. 1, 1*a*.

*Pterotocrinus coronarius* LYON and CASSEDAY, Proc. Amer. Acad. Arts and Sci., vol. 4, 1859, p. 302.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 2, 1881, p. 91; North Amer. Crin. Cam., 1897, p. 795, pl. 79, figs. 7*a*, *b*.—H. E. WILSON, Journ. Geol., vol. 34, 1916, pl. 3, fig. 11; note by F. S. on p. 492.

This species has a singular history. As originally described by Lyon, the type consisted of the tegmen only, being as stated by him a "unique crinoidal fragment," having "neither basal, radial nor arm plates." When Wachsmuth and Springer borrowed the type for description in the Camerata monograph we received the same specimen, and thus figured only the tegmen with the ponderous wing plates. While that work was going through the press I discovered in the Museum of Comparative Zoology at Harvard a lead cast of what was apparently the same specimen, but with the complete dorsal cup attached. No explanation of this fact was to be found, but I made a record of it in a footnote to page 795 of the monograph. When in 1903 I acquired the collection of the deceased Col. Sydney S. Lyon, I found associated with the tegmen constituting the published type the dorsal cup reproduced in the cast; the two parts were separated, but I have again united them in the position shown by the cast.

I was informed by Colonel Lyon's son, Victor W. Lyon, himself an experienced collector, that the two pieces were found together but detached; and from their color, size and lithological appearance there is every reason to believe that they pertained to the same individual. Mr. Lyon was of the opinion that subsequent to the description in the Kentucky Report his father became convinced that the fragments belonged together and accordingly united them, made and distributed the casts among his correspondents with the intention of amending the description when opportunity offered. This was prevented by the intervention of the Civil War through which he was an officer in the Federal army; the specimens were afterwards separated during one of the periodic inundations of the Ohio River by which the collection was submerged. The fact that they belong to the same species is proved beyond question by another specimen found associated with them having the same dorsal cup with one of the wing plates attached (pl. 14, fig. 2). Along with these, all from the same locality, is a third good cup and two other fragments—so that there is now in hand abundant material for the elucidation of the species. As now understood, the structure of the dorsal cup is fully as anomalous as that of the tegmen, presenting a wide departure from all other species of the genus.

In this species the basal plates are very small and flat, while the radials are of enormous size, larger than all the other plates of the cup combined; this being the reverse of the structure in *P. capitalis* and all other known species. In fact, the relative smallness of the radials is one of the striking differences between this genus in its usual form and its predecessors, *Dichocrinus* and *Talarocrinus*, while here the radials completely dominate the dorsal side; but instead of having a cylindrical exterior they form large gibbous protuberances, which occupy the greater part of the surface of the cup. The single primibrach and the secundibrachs are relatively large, and, as usual in the genus, the latter are articulated directly with the radial facet.

I am giving figures of the three important specimens upon which the foregoing statements are based. The species is exceedingly rare, no others having been found since Lyon's time among all the extensive collections made from the Chester group, except some isolated plates now thought to belong to it.

*Horizon and locality.*—Mississippian, lower part of the upper Chester, Golconda formation; Crittenden County, Kentucky. Lyon stated that the species was associated with *Pt.* (*Asterocrinus*) *capitalis*, another unusual form described by him at the same time. Extensive investigations of the Chester formations in recent years by Doctor Weller have shown that the latter species is an exceedingly characteristic fossil of the Golconda formation of Southern Illinois and Kentucky, which he correlates with the lower Okaw division of the Upper Chester, and that it is limited to that horizon. He has found the plates of *capitalis* in Johnson and Pope counties, Illinois.[27] And in a letter of December 29, 1921, he informed me that he had since found fragments of *Pt. coronarius* in the same beds. A species described by Hall in 1858 [28] as *Dichocrinus protuberans*, from a fragmentary base, probably is identical with this. It was said to be from Chester, Illinois, which, as collections were made at that time, might mean anywhere in that region.

### PTEROTOCRINUS CAPITALIS (Lyon)

Plate 13, fig. 23

*Asterocrinus capitalis* LYON, Geol. Rep. Kentucky, vol. 3, 1857, p. 472, pl. 3, figs. 1*a*–*h*.

*Pterotocrinus capitalis*, LYON and CASSEDAY, Proc. Amer. Acad. Arts and Sci., 1859, p. 301.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 794, pl. 79, figs. 6*a*, *b*.

Lower part of upper Chester, Golconda formation; Crittenden County, Kentucky, Johnson and Pope Counties, Illinois.

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[27] Illinois State Geol. Surv. Bull. 41, 1920, p. 184.

[28] Geol. Rep. Iowa, pt. 2, p. 689, pl. 25, fig. 7.

### PTEROTOCRINUS PYRAMIDALIS Lyon and Casseday

Plate 13, figs. 21, 22

*Pterotocrinus pyramidalis* LYON and CASSEDAY, Amer. Journ. Sci., vol. 29, 1860, p. 69.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 798, figs. 4*a*, *b*.

Upper Chester, Glen Dean formation; Grayson Springs, Kentucky.

### PTEROTOCRINUS DEPRESSUS Lyon and Casseday

Plate 14, figs. 4, 4*a*

*Pterotocrinus depressus* LYON and CASSEDAY, Amer. Journ. Sci., vol. 29, 1860, p. 68.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 796, pl. 79, figs. 2*a–e*.

Upper Chester, Glen Dean formation; Grayson, Pulaski, and Breckinridge Counties, Kentucky.

### PTEROTOCRINUS ACUTUS Wetherby

Plate 13, fig. 16

*Pterocrinus acutus* WETHERBY, Journ. Cincinnati Soc. Nat. Hist., vol. 2, 1879, pl. 11, figs. 2*a–e*.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 799, pl. 79, figs. 3*a–g*.

Upper Chester, Glen Dean formation; Pulaski and Breckinridge Counties, Kentucky.

### PTEROTOCRINUS BIFURCATUS Wetherby

Plate 14, fig. 5

*Pterotocrinus bifurcatus* WETHERBY, Journ. Cincinnati Soc. Nat. Hist., vol. 2, 1879, p. 136, pl. 11, figs. 1*a–c*.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 801, pl. 79, figs. 9*a*, *b*.

Upper Chester, Glen Dean formation; Sloan's Valley, Pulaski County, Kentucky.

## HETEROTOMOUS BRANCHING OF THE ARMS

In order to complete the story of the ramifications of *Dichocrinus*, attention should be called to the species *D. polydactylus* Casseday and Lyon,[29] from the Keokuk limestone, which has gone off upon a new line in regard to arm structure. All other species have dichotomous arms, branching by approximately equal bifurcations. In this one, however, the ray divides into two main branches, from which usually three subordinate branches are given off to the outer side of the dichotom, thus producing one form of unilateral heterotomy—a difference which in other groups has been regarded as sufficient for generic separation. This is not an isolated or sporadic occurrence, for it is one of the strongest species of the genus, from the great crinoid colony at Crawfordsville, Indiana, as is evidenced by upwards of fifty good specimens in my own collection, all thoroughly constant in this character.

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[29] Proc. Amer. Acad. Arts and Sci., vol. 5, 1860, p. 18. WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, p. 756, pl. 77, figs. 1*a*, *b*.

Furthermore, I have in recent years acquired some specimens of this type from the lower horizon at Indian Creek, which persistently differ from the Crawfordsville form in characters sufficient for specific definition. Both species attain a large size, far larger than any others that have been referred to *Dichocrinus*, the crown in mature specimens being upwards of 10 cm. in height; and in both the posterior interradius in the tegmen is raised into a pyramid as high as the cup, the summit of which lodges the anus.

In view of this pronounced differentiation in arm structure represented by two species, one of which has to be described as new, it seems advisable to place them in a separate genus based on the foregoing characters, for which I propose the name *Paradichocrinus*, with *P. polydactylus* as genotype.

## PARADICHOCRINUS, new genus

Mississippian, Keokuk.

### PARADICHOCRINUS PLANUS, new species

Plate 10, figs. 2, 3, 4

Similar to *P. polydactylus*, except that the dorsal cup plates are smooth, without nodes or tubercles with which that species is profusely ornamented, and the arms usually give off four subordinate branches to the outer side of the dichotom, making ten arms to the ray; also the specimens average rather larger than those of that species, a maximum crown being 10.5 cm. in height. Five specimens have appeared, all from the Indian Creek colony, in which these characters are well maintained. Three have the arms complete, showing with but a single exception the number constant at ten to the ray, whereas in *P. polydactylus* 36 out of 44 specimens with arms, or 80 per cent of the whole, have 8 arms to the ray, five of the others having 9, and one or two 10. All the specimens agree in lacking the pustulose ornament so conspicuous in *P. polydactylus*, of which for comparison I give a figure showing the base, and another a posterior view of the calyx (pl. 10, figs. 5, 6).

*Horizon and locality.*—The genus and both species are restricted to the Keokuk limestone of the Mississippian, *P. planus* occurring at Indian Creek, and *P. polydactylus* at Crawfordsville, Indiana.

## UNEQUAL RADIALS

Usually the radial plates of a crinoid, as well as the arm structures which they support, are symmetrically arranged, and substantially alike in size and form. Exceptions to this rule must be noted in the cases of compound radials, of a primitive radianal, and of many genera in which there is a regular difference among the rays in the number of arm openings or of arm branches;[30] also some slight irregularities in the size of radials and other plates, as in *Dolatocrinus*.[31] A conspicuous example of complete departure from equality among the radials is furnished by the family Catillocrinidae, in which certain radials regularly exceed the others greatly in size, and bear a greater number of arms, which I have already discussed in a separate paper;[32] and another equally striking by the family Cremacrinidae, in which, in conjunction with the bending of the crown, one or mostly two arms have disappeared, and of those that remain two are peculiarly modified; the group has been elaborately treated by Bather[33] under the name Calceocrinidae. Other isolated instances of defective radiation arising from the loss or atrophy of certain rays may be cited, such as *Atelestocrinus*, *Tribrachiacrinus*, *Trigonocrinus*, *Tetracrinus*, *Lageniocrinus*, *Monobrachiacrinus*, *Embryocrinus*, and other new genera described by Wanner from Timor.

Another remarkable case of this kind is to be seen in the Silurian genus *Cholocrinus* of the Flexibilia, which I have described when treating of that group.[34] In that genus, while the radials themselves are not so very different in size, the arms in the two antero-lateral rays are dwarfed almost to the extent of atrophy. In the discussion I alluded to a species described by Whitfield from the Chester in which an opposite irregularity appears, the antero-lateral rays being disproportionately enlarged. The inequality of the rays in Whitfield's species goes one step farther than that seen in other species, in that while in them it occurs among the different rays of the same specimen, in this it lies also between the two branches of the same ray, taking the form of a distinct and constant hypertrophy of certain arms. I wish here to consider it in somewhat greater detail partly for that reason, and partly because it proves to be related to a genus which is closely associated geologically with some of those just discussed, and which, although one of the most numerous and widely distributed forms of the Chester group, and the subject of frequent mention in crinoid literature upon morphological grounds, has hitherto not been understood, namely:

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[30] Springer, Crinoidea Flexibilia, 1920, p. 171–2.

[31] Springer, Bull. 115, U. S. Nat. Mus., 1921, p. 18.

[32] On the Fossil crinoid family Catillocrinidae, Smithsonian Misc. Coll., vol. 76, 1923, No 3.

[33] Crinoidea of Gotland, 1893, p. 54. Also Jackel, Philogenie und System, 1918, pp. 86, 88.

[34] Crinoidea Flexibilia, 1920, p. 170.

## Genus AGASSIZOCRINUS Owen and Shumard

Plate 15

*Agassizocrinus* TROOST, Ms., Proc. Amer. Assn. Adv. Sci., 1850, p. 60. Not defined, *nomen nudum*.—OWEN and SHUMARD, Journ. Acad. Nat. Sci. Phila., ser. 2, 1852, p. 93.—SHUMARD, Marcy's Red River Exped., 1854, p. 173.

*Astylocrinus* ROEMER, Lethaea Geognost., 1855, vol. 1, pl. 2, p. 229.

*Agassizocrinus*, WACHSMUTH and SPRINGER, Rev. Pal., pt. 3, 1886. p. 262.—S. A. MILLER, N. A. Geol. and Pal., 1889, p. 221.—BATHER, Lankester Zoology, pt. 3, 1900, p. 103.—ZITTEL-EASTMAN, Textb. Pal., 1913, p. 224.[35]

Mississippian, Upper Chester.

The following species, in chronological order, have been described under this genus, or referred to it; all upper Chester unless otherwise stated:

1852. *Agassizocrinus conicus* OWEN and SHUMARD, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 2, p. 93, pl. 11, fig. 6; Geol. Sur. Iowa, Wis. and Minn., 1852, p. 597, pl. 5B, fig. 6.—MEEK and WORTHEN, Geol. Surv. Ill., vol. 5, 1873, pl. 21, fig. 8.

Elongate conical; no marks for insertion of column; base (IBB) composed of 5 pieces closely adhering, usually anchylosed; IBB cone extremely high, higher than in any species subsequently described; height to width to height of IBB, in mm., 25/17/15. Chester, Illinois.

1852. Also described in the same publication as *Poteriocrinus*, and referred by subsequent authors to this genus: *A tumidus* (Owen and Shumard), p. 90, pl. 11; figs. 3*a*, *b*. *A. occidentalis* (Owen and Shumard), p. 92, pl. 11, figs. 5*a*, *b*. Both Chester, Illinois.

1854. *A dactyliformis* SHUMARD, Marcy's Red River Exped., p. 173, pl. 1, fig. 7. Washington county, Arkansas.

1855. *A. laevis* (ROEMER), Lethaea Geogn., vol. 1, pl. 2, p. 229, pl. 4, figs. 13*a–d* (as *Astylocrinus*). Figs. *b*, *c*, *d* are from the small basal cones found in great abundance on Prairie du Long creek in Randolph county, Illinois; fig. *a* from a nearly complete specimen said by the author to be from Indiana, but the authentic type is from Chester, Illinois.—PICTET, Traité d. Pal., 1857, vol. 4, p. 291, pl. 99, fig. 8: copied from Roemer with some changes, among them inserting a circlet of divided plates above the basal cone, making 4 ranges of plates.—(As *A. dactyliformis* Troost), MEEK and WORTHEN, Ill., vol. 5, 1873, pl. 21, figs. 7*a*, *b*.—S. A. MILLER, North Amer. Geol. and Pal., 1889, p. 221, fig. 240.—TROOST, Ms., *nomen nudum*. Proc. Amer. Assn. Adv. Sci., 1850, p. 60; Bull. 64, U. S. Nat. Mus., 1909, p. 96, pl. 12, fig. 1.

Large, broadly rounded ovate; base fused, with traces of sutures in upper part; IBB more than ½ total height of calyx; H to W to IBB 21/19/9. Chester, Illinois.

1858. *A. gibbosus* HALL, Geol. Iowa, pt. 2, p. 686, pl. 25, fig. 6.—WORTHEN, Ill., vol. 5, p. 556, pl. 21, fig. 11.

Small, broadly conical; base fused, IBB not over ⅓ total height of calyx; 12/11/4. Chester, Illinois.

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[35] I am not attempting to give complete synonymy under any of the genera, but only such references as will indicate the chief sources of information and facilitate the consideration of the forms under discussion.

1858. *A constrictus* Hall, Iowa, p. 687, pl. 25, fig. 10.
Small, narrow conical; IBB divided, high, constricted, more than ⅛ total height; 14/9/6. Chester, Illinois.

1867. *A. papillatus* Worthen, Bull. 1, Illinois State Mus., p. 36; Ill., vol. 7, 1882, p. 315, pl. 29, fig. 17.
Small, subovate, wider than high; IBB divided, with 2 or 3 joints of column attached, very low; 8/11/2. Probably lower Chester, Monroe County, Illinois.

1867. *A. hemisphericus* Worthen, Bull. 1, Illinois State Mus., p. 37; Ill., vol. 7, 1882, p. 316, pl. 29, fig. 7.
Small, low, globose, much wider than high; figures show column facet and divided IBB, but description says no column facet; IBB very low; 6/9/1.5. Randolph County, Illinois.

1873. *A. pentagonus* Worthen, Ill., vol. 5, p. 556, pl. 21, figs. 10*a*, *b*.
Small, wider than high, pentagonal outline; BB concave; IBB divided, with distinct column facet, low; 13/15/4. Chester, Illinois.

1873. *A. globosus* Worthen Ill., vol. 5, p. 557, pl. 21, figs. 12*a*, *b*, *c*.
Small, globose, wider than high; IBB divided, with small, round column facet, very low; 12/14/2. Chester, Illinois.

1873. *A. chesterensis* Worthen, Ill., vol. 5, p. 558, pl. 21, fig. 9.
Medium size, ovoid, higher than wide; faint trace of column attachment, but no suture lines visible; IBB low. Chester, Illinois.

1873. *A. carbonarius* Worthen, Ill., vol. 5, p. 566, pl. 24, fig. 4.
Fused basal cone only. Coal Measures; Shelby County, Illinois.

1896. *A. ovalis* Miller and Gurley, Bull. 9, Illinois State Mus., p. 36, pl. 2, figs. 13, 14.
Medium size, globose; no evidence of a column; IBB very low; 14/15/3. Randolph County, Illinois.

1920. *A. dissimilis* Weller, Bull. 41, Geol. Surv. Illinois, p. 544, pl. 5, figs. 29, 30.
Small, globose, sutures deeply incised; IBB fused. Lower Chester, Paint Creek formation; St. Clair County, Illinois.

Although the name *Agassizocrinus*, and what was formerly held by some authors to be the type species, *A. dactyliformis*, was given by Troost in 1850, yet it was Owen and Shumard who first published, crediting Troost with the genus, a description and figure of a species of their own, by which the generic characters may be readily recognized; therefore under the law of priority the genus must be credited to them, and their species, *A. conicus*, must be accepted as the genotype. The fact that Shumard two years later, in connection with the description and figure of a species which he called *A. dactyliformis*, published a short account of the genus, crediting both to Troost, does not affect the record with regard to the genus.

Even as to the species the record is peculiarly complicated. The genus is most widely known by the form described by Roemer in the Lethaea Geognostica, 1855, as *Astylocrinus laevis*, with a beautiful figure of what was said to be a "nearly perfect specimen," made from a cast furnished by Shumard, but having the arms considerably restored. This figure, somewhat amended, was copied by Pictet;

and afterwards by Meek and Worthen,[36] but under the name "*Agassizocrinus dactyliformis* Troost," as of a "specimen perfect in all its parts," along with another figure (*7b*) said to be "from a specimen in the State collection"; their figure was in turn copied under the same name by S. A. Miller,[37] and under Roemer's name by Zittel in the Grundzüge (1895, p. 137), and Zittel-Eastman in Text-book of Paleontology, editions of 1896 and 1913 (pp. 162 and 224); thus it was given a wide circulation both in this country and in Europe.

Shumard's description and figure of *A. dactyliformis* in 1854 were made from an imperfect calyx, consisting only of the fused infrabasals and part of the basals, and for any close comparison of species may be disregarded. But none of these publications, although all using Troost's name, brought out the authentic type specimen on which Troost proposed the species, which was not done until 1909, when his monograph was published by the U. S. National Museum, edited by Miss Wood. Hence all the figures based on the Roemer type, either the original or copies, must be called *A. laevis;* and Troost's species, *A. dactyliformis*, must fall under it as a synonym.

The original specimen from which Roemer's figure was made is now in my possession, formerly in the collection of B. F. Shumard, and I am giving photographs of it after some additional preparation (pl. 15, figs. 5, 5*a*). From this it will be seen that while restoring the lacking parts of the arms, Roemer missed the important element of the anal plates, which were not shown in his cast because concealed by the matrix.

In order to have an authentic starting point, I am also figuring the type specimen of Owen and Shumard's genotype, *A. conicus*, now in the United States National Museum (pl. 15, fig. 1). In addition to these, I have prepared a number of figures from complete calices as found in several localities throughout the region in which the genus abounds, among which may be identified some of the numerous species which have been described, based upon the more or less conical or globose form of the calyx (pl. 15). These specimens are also important in connection with the newly discovered leading character of the genus, to be presently explained.

*Agassizocrinus* is typically a late Chester form. Its earliest observed occurrence is in the upper Ohara, or Renault formation of the lower Chester; but it becomes common in the lower Okaw division of the upper Chester under its local appellations of Golconda, Gasper, etc., and what is known as the *Pentremites godoni* bed. It continues in great abundance in the upper Okaw, Glen Dean, etc., division to the end of the Chester, with which it becomes practically extinct—a single species, *A. carbonarius*, having been recognized by Worthen from an isolated fragment in the Coal Measures of Illinois. As showing the broad distribution of this crinoid, I may add that I found a specimen of the common infrabasal cup at Santa Fe, New Mexico, in a formation on the flank of the Rocky Mountains strongly resembling the upper Chester, but now correlated as Pennsylvanian.

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[36] Ill., vol. 5, pl. 21, fig. 7*a*.

[37] North Amer. Geol. and Pal. p. 221.

Fragmentary specimens consisting of the detached bases occur throughout the upper Chester by the hundreds at all the principal localities in southern Illinois, Kentucky, Tennessee, Alabama, Virginia, Ohio, and Arkansas. Complete calices are rare, and very few have been seen with any part of the arms attached; but I have been fortunate in obtaining several of these in condition available for the comparison about to be made.

One of the generally accepted traditions about *Agassizocrinus*, and the character by which it is chiefly known and most frequently referred to in morphological discussions, is that it was a stemless crinoid, at least in the adult stage. Shumard describes it thus in the Marcy Report:

> In young individuals the division of the pelvis into 5 pieces is well marked, but in adult age they are usually firmly anchylosed and often all traces of sutures obliterated.

This has been adopted as a settled conclusion by Wachsmuth and Springer and authors generally. Nevertheless the known facts do not bear out this dictum without qualification.

Among 250 specimens of detached bases from the Gasper formation at Huntsville, Alabama, mostly of medium size, from 7 to 15 mm. in diameter, about 200 have the infrabasals anchylosed, while about 35 below medium size and 15 of medium size or larger have traces of infrabasal sutures and column facet; among these one of the largest in all the collections, 20 mm. in width, has the infrabasals well divided on the inside (compare figures 21 and 23 on plate 15 for the two extremes). From the same formation in Breckinridge County, Kentucky, there are about 70 specimens, of which 23 show the infrabasals divided at the inside, 18 at the outside with the column facet traceable, and the remainder have the infrabasals completely anchylosed; these differences are not strictly related to size, some of those with column facet present being among the larger.

Specimens are numerous in the collections from the Glen Dean formation in Grayson and Pulaski counties, Kentucky. Out of upwards of 200, about one-fourth (mostly the smaller ones but also some of above medium size) show infrabasal sutures on the inside; some of fairly average size have the infrabasals distinctly divided, and the column facet present (pl. 15, figs. 10, 11); and also a few have portions of arms. In the remainder the infrabasals are fused.

From the Chester region, upper Okaw, equivalent to the Glen Dean formation of Kentucky, in Randolph and adjoining counties in southern Illinois, from which most of the described species have been derived, there are about 70 specimens; in about 60 of these all traces of infrabasal sutures are absent, while in 10 these plates are divided, and traces of column facet visible. The specimens range from 8 to 20 mm. in diameter. Roemer's type is 19 mm. wide, and shows a sutural division at the upper part of the infrabasals, but no trace of a column facet.

Among the 15 described species, as shown by the descriptions and figures, the following have the infrabasals completely fused, and all trace of column absent: *A. conicus*, *A. dactyliformis*, *A. laevis*, *A. gibbosus*, *A. chesterensis*, *A. dissimilis*, and *A. carbonarius*,=7. These have the infrabasals divided, and a column facet present: *A. occidentalis*, *A. tumidus*, *A. constrictus*, *A. papillatus*, *A. pentagonus*, and *A. globosus*,=6. Of the remaining two, *A. hemisphericus* and *A. ovalis*, the figures show the infrabasals divided, but the descriptions say there is no evidence of a column. Thus at least 40 per cent of the described species had a column, and there is nothing in either figures or descriptions to indicate that these were based upon immature individuals.

On examining the specimens with reference to the fusion of the base several conditions will be found: some have the infrabasals completely anchylosed—usually a good sized cone; some have them well divided, with a facet suitable for the attachment of the column; in some they appear divided only at the inside of the cup; still others have a more or less imperfect division, with suture lines ragged or curving (pl. 15, figs. 18, 19), as if in a transition state, or one in which the sharp definition of the suture is hindered by a restricted mode of growth, accompanied by the formation of zigzag radiating nerve canals, passing out into the wall of the cup instead of down into a stem (pl. 15, fig. 24).

In 1882 Whitfield described a species from the upper zone of the Maxville formation of Ohio, equivalent to the Glen Dean of Kentucky, under the name *Cyathocrinus inequidactylus*.[38] Some years afterwards, finding the name preoccupied, he republished the description, changing the specific name to *C. maxvillensis*.[39] He had three specimens, of which he gave good figures, the arms being partly preserved in two of them. The distinctive character of the species as defined was the inequality of the arms, the structure of which was described as follows:

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[38] Ann. New York Acad. Sci., vol. 2, p. 219, pl. 9, figs. 5–8.

[39] Idem. vol. 3, Feb. 1891, p. 577, pl. 13, figs. 5–8; Geol. Surv. Ohio, vol. 8, 1893, p. 465, pl. 9, figs. 5–8.

> Second radials, or first arm plates, smaller than the first radials and narrowing upward; wedge formed above, and each supporting two arms. On the postero-lateral, with the arms slender. On the anterior ray it is short and supports two slender arms; while on the antero-lateral rays they support a slender arm similar to those of the other rays on the anterior side, and on the outer side an arm several times larger and stronger than the others, and composed of longer and stronger plates.

That is to say, there are 10 arms, but those on the axillary faces of the antero-lateral primibrachs are unequal, the branch on each outer face (toward the posterior side) being hypertrophied, thus giving two disproportionately large arms, and eight, much smaller, about equal among themselves.

In one of the specimens the strong antero-lateral arm is preserved to more than an inch. In all three the infrabasals are distinctly divided, forming a rather low conical cup, to which a well developed stem is attached.

Now the radial facets occupy the full width of the radials, and are equipped with a complete muscular articulation, while the anal side is that of the later Poteriocrinidae; so it was long ago evident that this species does not belong to the genus *Cyathocrinus*. Casting about to find a place for it, having meantime acquired an excellent specimen clearly belonging to the species, I was struck with the resemblance of the calyx in all essential characters to that of those species of *Agassizocrinus* having divided infrabasals and a column facet. Upon reviewing my material which has been referred to that genus, I found two specimens with the arms transversely fractured which plainly disclosed in cross section the two hypertrophied arms, precisely as in Whitfield's specimens. In both of these also the infrabasals are divided, and a distinct column facet is present.

Upon making careful measurements I found that the difference in the size of arms was reflected in the width of the radials at the distal facet, which was nearly the same in the two specimens, the mean of the two, in millimeters, being:

| ant. | l. ant. | l. post. | r. post. | r. ant. |
|---|---|---|---|---|
| 6.5 | 7 | 5.2 | 5.2 | 6.7 |

This suggested the probability that similar measurements might furnish a clue to the existence of unequal arms in specimens in which only the calyx was intact. I thereupon assembled all such specimens supposed to belong to *Agassizocrinus*, from five of the principal regions, and tabulated the data for the width of the radial facets, measured at the outside in 15 of these, of which 6 have the infrabassals divided and the column facet or distinct traces of it present, and 9 have the infrabasals fused. Taking the means for the two sets, I obtained a composite for each, and for the whole, as follows:

| | ant. | l. a. | l. p. | r. p. | r. a. |
|---|---|---|---|---|---|
| IBB divided | 6.1 | 7 | 5.6 | 5.4 | 7 |
| IBB undivided | 6.3 | 7.3 | 6.1 | 5.9 | 7.1 |
| General average | 6.2 | 7.15 | 5.8 | 5.6 | 7.05 |

Four specimens not included in the table, while having the same relative widths otherwise, have the anterior radial as wide as, or wider than, the two lateral radials; which indicates that in some specimens the enlargement extended to the anterior ray while the two posterior remained small, which might not be unexpected with an abnormal character like this.

Thus it appears that throughout the entire assemblage of specimens, which includes representatives of the best known species, including some types, the radials differ in width with a certain regularity which is expressed by the mean of all the measurements; and that taking this mean as conclusive evidence of the facts, the two lateral radials exceed the two posterior radials in width by about 1.3 mm., and the anterior radial by about two thirds of that amount—this excess being enough in most cases to accommodate the greater width of arm on one face of the axillary primibrach, the faces of which differ in the proposition of about 3 to 2, or 5 to 3. Also that this difference is not confined to those forms having divided infrabasals and a stem, but is equally pronounced in those having the infrabasals anchylosed and all traces of stem obliterated.

Among the material under consideration are the type specimens of two of the earliest described species of *Agassizocrinus:* 1. That of the genotype, *A. conicus* of Owen and Shumard, U. S. National Museum, Catalogue No. 17937, sent in 1887 from the University of Indiana, where it had been deposited by David Dale Owen, along with other types of species described by him and Shumard in the second of their papers in the Philadelphia Academy of 1852 (those of the first paper being now in the University of Chicago); one radial is not visible (pl. 15, fig. 1). 2. That of Roemer's *A. laevis*, already mentioned. Corresponding measurements of these give the following widths:

| | ant. | l. a. | l. p. | r. p. | r. a. |
|---|---|---|---|---|---|
| *A. conicus* | 9 | 10 | -------- | 7 | 10.5 |
| *A. laevis* | 9 | 9 | 8 | 8 | 9 |

Thus we find the same relative excess in width of the lateral radials over the posterior radials. Hence the inequality of radials shown to exist in the specimens generally is now found to be a character in the types of those species which have been considered typical of *Agassizocrinus*, including the genotype itself. Although in these two specimens the anterior radial is also more or less enlarged, as in some others before mentioned, it does not follow that the same inequality of arms extends to that ray. For in the *A. laevis* type I was able, by additional preparation, to expose the distal faces of the axillary primibrachs all around, with the interesting result that while in the antero-lateral rays the faces of the axillary are 6 and 4 mm. respectively, in the anterior ray the faces are equal at 5 mm.—those in the posterior rays being 4.5 mm.; so that while in some specimens the anterior arms may be a little larger than the posterior, there is probably no such hypertrophy or inequality as exists in the latter in Whitfield's species. Not only so, but this specimen as now prepared affords a comparative view of the posterior arms and the antero-lateral arm next to them, by which the greater size of the latter can be plainly seen (pl. 15, fig. 5*a*).

By way of a check upon these observations, and in order to see whether analogous differences might not exist among the rays of other closely related genera, I tabulated the widths of the radial facets in 26 specimens from the same formations and localities, belonging to three species of *Eupachycrinus*, which has the anal side identical with that of *Agassizocrinus*, with the result that the mean width of the five radials differs not exceeding 0.5 mm. between any two of them, and not according to any definite plan. The composite of the 26 is as follows:

| ant. | l. a. | l. p. | r. p. | r. a. |
|---|---|---|---|---|
| 8.9 | 9 | 8.6 | 8.5 | 8.7 |

The obvious conclusion from these facts is that the anomalous arm structure exhibited in Whitfield's species pertains more or less to the species of *Agassizocrinus* generally, and that the dominant character of the latter genus is not the absence of a stem but the hypertrophy of certain arms in two (perhaps occasionally three) of the rays, producing an asymmetry within the ray itself; that the fusion of infrabasals is not entirely a matter of adult growth (although the elimination of the stem is undoubtedly an adult character in the ontogeny of the crinoids) but that the instability of the base follows a tendency to change directly associated with the abnormal modification of the arms. It may thus be a character which became fixed in certain species, or it may have occurred sporadically or at different stages of growth in different species. Thus F. B. Meek commenting in 1874 on the figures of *Agassizocrinus* on plate 21 of volume 5 of the Illinois Reports says:

> Some species, such as those represented by figs. 10 and 12, may even have remained attached by a slender column during their whole life.[40]

The further obvious conclusion follows that Whitfield's species must be referred to *Agassizocrinus* with a modified diagnosis, and that inasmuch as his original specific name was not preoccupied under the genus to which it now proves to belong, it must under the rules of nomenclature be now restored, and the species written *Agassizocrinus inequidactylus* (Whitfield).

I have reserved for special mention the particular specimen which led me to the present investigation, and which by reason of its excellent preservation gives us the most striking picture of the remarkable specialization which has developed in this genus. It was acquired with the collection of the late Col. S. S. Lyon, who had recognized its anomalous structure, and, as I have elsewhere stated, proposed to describe it under one of his favorite hyphenated names as *Poteriocrinus brachialis-irregularis*. The two ponderous antero-lateral arms are almost complete, and they show better than the measurements of radials what an enormous difference in size there is between them and the other arms (pl. 15, fig. 13). The specimen has the infrabasals divided, and a column facet with axial opening; and it belongs beyond question to the species described by Whitfield.

In the structure of the anal interradius there is no appreciable difference between the species referred to *Agassizocrinus* and those of *Cromyocrinus* and *Eupachycrinus*, which are all closely associated in geological position. Bather in the Lankester Zoology (pt. 3, p. 103), defined *Agassizocrinus* as "a *Cromyocrinus* that loses its column in adult life, while IBB fuse to a solid mass." With the knowledge furnished by the present investigation we are able to place the definition of *Agassizocrinus* upon a surer basis, distinguishing it from the other two genera by the inequality of the radii due to the greater size of the two lateral rays, and of one of the arms of which they are composed, and perhaps exceptionally of the anterior ray also. This will be irrespective of the presence or absence of a stem, although the strong tendency to fusion of the base and elimination of the stem is recognized:

### Genus AGASSIZOCRINUS Owen and Shumard

Poteriorcrininae with calyx elongate to pyriform. Infrabasals five, with facet for round column often present, but more frequently fused into a rounded conical base, on which all trace of column is wanting. Radials unequal, those of the two lateral rays (and sometimes the anterior) larger than the others; primibrachs usually one, that of the lateral rays unsymmetric, and supporting on the longer articular face a greatly hypertrophied arm. Arms ten, unequal, uniserial, brachials mostly quadrangular; pinnules small and closely packed. Ventral sac unknown, probably inconspicuous or wanting.

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[40] Amer. Journ. Sci., vol. 7, p. 484.

*Distribution.*—Carboniferous, Chester to Pennsylvanian.

There must now be added to the list of species given above:

### AGASSIZOCRINUS INEQUIDACTYLUS (Whitfield)

*Cyathocrinus inequidactylus*, Ann. New York Acad. Sci., vol. 2, 1882, p. 219, pl. 9, figs. 5–8.

*Cyathocrinus maxvillensis* WHITFIELD, Ann. New York Acad. Sci., vol. 5, 1891, p. 557, pl. 13, figs. 5–8; Geol. Surv. Ohio, vol. 7, 1893, p. 465, pl. 9, figs. 5–8.—MORSE, Proc. Ohio State Acad. Sci., vol. 5, 1911, p. 361, 362, figs. 3*a*–*d*.

Belongs to the subconical type, of medium size, and well characterized by a low cone of perfectly divided infrabasals and a strong stem. Highest part of the Chester, Maxville limestone (upper zone) and Glen Dean formations. Type locality near Newtonville, Clermont County, Ohio; also occurs at Sloan's Valley, Pulaski County, Grayson Springs, Grayson County, and Stephensport, Breckenridge County, all in Kentucky, but has not been reported from the equivalent Okaw of the southern Illinois area.

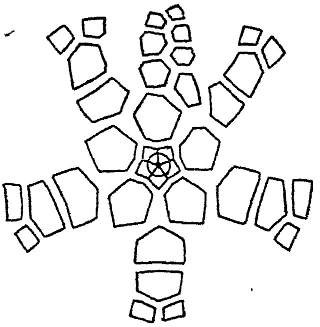
FIG. 1. ANALYSIS OF CALYX OF AGASSIZOCRINUS

Like many other species of the Glen Dean formation this is a wide ranging form. In addition to Whitfield's types from Ohio, four specimens have been found at three widely separated localities in Kentucky, all from the uppermost beds of the Chester; they are figured on plate 15. The nearly conical contour of the calyx and low infrabasal cone are constant in all.

While I am not essaying a critical review of the species of *Agassizocrinus*, yet in view of its profuse occurrence and wide distribution, and the desirability of having the status of the species fixed as far as possible, I will attempt briefly to summarize our information regarding them:

Of the seventeen described species (including Whitfield's and a new species), two-thirds of which are based upon specimens from the vicinity of Chester, Illinois, three may be excluded from consideration because not sufficiently defined to show more than generic characters, namely: *A. dactyliformis* Shumard, *A. tumidus* Owen and Shumard, and *A. carbonarius* Worthen.

Five may be accepted distinguished by well defined special characters, some of which may be only individual variations, namely:

1. *A. conicus* Owen and Shumard, by its strictly conical and very elongate form, large size, and great relative height of the infrabasal cone, which is more than half the height of the calyx (pl. 15, fig. 1).

2. *A. laevis* Roemer, by its broadly rounded, ovoid calyx, of which the base is more than one-third its height (pl. 15, fig. 5) ; this includes Troost's Ms. species, *A dactyliformis*, and the specimen figured by Meek and Worthen in Illinois (vol. 5, pl. 21, fig. 7).

3. *A. constrictus* Hall, by its very elongate, narrow calyx, and constricted base.

4. *A. pentagonus* Worthen, by its pentagonal outline, and concave basal plates.

5. *A. dissimilis* Weller, by its deeply incised sutures.

Nos. 1, 2, and 5 have the infrabasals fused.

Of the remaining species, which include three synonyms, six might be arranged, for want of any better criterion, according to the general form of the calyx as used in many of the descriptions, whether subconical, ovoid, or globose; to which may be usefully added the relative height of the infrabasal cone or disk:

6. *A. gibbosus* Hall, syn. *A. chesterensis* Worthen; subconical, but much more rounded and less elongate than *conicus*, both as to the entire calyx and the infrabasal cone, the height being slightly more than the greatest width, and the infrabasals one-fourth to one-third the height of calyx; infrabasals fused (pl. 15, fig. 8).

Widely distributed, found in all the principal Chester areas.

7. *A. inequidactylus* (Whitfield) ; similar to last, only having infrabasals divided and a column; and being more elongate and more distinctly conical in form (pl. 15, figs. 10–13).

8. *A. papillatus* Worthen, syn. *A. hemisphericus* Worthen; and (?) *A. occidentalis* Owen and Shumard; calyx globose, wider than high; infrabasals forming a low disk, less than one-fourth the height of calyx, divided, with a column facet. *A. occidentalis* is included here with a (?) ; if the characters were certain it would have to head the group, being earliest in date. Probably from the Paint Creek formation, a lower horizon than all the others except No. 5.

9. *A. globosus* Worthen; characters not materially different from the last, but it is slightly larger, and from a higher horizon, being characteristic of the Gasper formation, especially in Breckrenridge County, Kentucky (pl. 15, fig. 14).

10. *A. ovalis* Miller and Gurley; same as last, except that while the figures show divided infrabasals, the descriptions say there is no evidence of a column (pl. 15, figs. 15, 16, 17).

11. *Agassizocrinus lobatus*, new species. A thoroughly distinct species, from the Gasper formation at Huntsville, Alabama, represented by 12 specimens that only came to light in the collection after the foregoing discussion was prepared. It is remarkable for having the infrabasal cup (which is the only part known) strongly lobed next to the top, and more or less divided, while it is rounded and fused at the bottom. I have figured a set of six of the cups in which these characters are fully shown (pl. 26, figs. 13–18).

As a fairly general rule, it seems that those forms with a well rounded ovoid or globose calyx, combined with very short infrabasals, have mostly a divided base; but the subconical No. 7 has it also.

Thus the recognizable species are reduced to eleven, and it is probable that there are still more synonyms, but the material is not at hand for close comparison of some species.

## THE INFLATED VENTRAL SAC

The leading character of the Fistulate division of the Crinoidea Inadunata is the great development of the posterior interradius, which in some genera takes the form of an elongate anal tube with the opening at the distal end, while in others almost the entire tegmen is extended into a closed sac, in which the anal opening, instead of being at the distal end, or at the posterior side, is located at the anterior side of the tube, either at the base, or part way up, sometimes at the end of a lateral spout.

This organ exhibits various forms and modifications, some of which are illustrated by Wachsmuth and Springer on plate 7 of the North American Crinoidea Camerata. It is not my purpose to discuss these structures in detail, further than is desirable to clarify our knowledge in regard to one of them that has hitherto been obscure, and to supply some needed information regarding certain species which for lack of adequate illustration have not hitherto been clearly understood, several of the important ones never having been figured at all. The modification which I wish especially to consider is the one which is characterized by a peculiar reversal in the position of the anal opening, by which in certain forms it emerges at the anterior side instead of the posterior, where it is usually expected. This has been a perplexing fact in the morphology of the group, giving rise to some rather far-fetched theories for its explanation. Later investigations, as I have hitherto stated in the Flexibilia monograph, indicate that there is no essential difference between the "anal tube," such as is found in *Cyathocrinus*, and the "ventral sac," as in *Aulocrinus;* and that all forms of tube in which the anus is not at the distal end may be explained by the recurving of the gut with its enveloping tube in its upward or distal extension, from the vertical toward the anterior side, folding or doubling back upon itself more or less completely, so that the opening may emerge through the wall of the tube at any point between the distal end and the base.

The tendency of the tube, perhaps primarily owing to some obstruction in the early stages, is to expand at or near the point where it is bent, either producing a rounded or nodose enlargement, or developing a variety of peculiar inflated or spiniferous structures, which have been called balloon-shaped or mushroom-shaped. Some of these extend beyond the limits of the arms, surmounting the crown with a conspicuous expanded appendage; others are wholly enclosed by the arms. All are enlarged extensions of a narrow neck by which they are connected with the cup.

This form of sac was especially developed in the Lower Carboniferous, where it is characteristic of a considerable group of genera, beginning in the earliest members, the Kinderhook and Lower Burlington, with the genus *Coeliocrinus*, a variable form, which continued with modifications into some of the later formations, and was succeeded toward the close by *Hydreionocrinus*, which combines one of its forms of sac with a different type of calyx and arm structure, and as thus modified passed on to the Upper Carboniferous. The sac with the infradistal position of the anus is subject to considerable modification in details of structure, and in one form or another occurs as a conspicuous feature in several genera besides the two above named. It is also found associated with different plans of arm arrangement and forms of calyx. As to these characters there is no very stable correlation, and the lack of fixity in this respect is often confusing.

For example: *Pachylocrinus arboreus* (Worthen) and *P. florealis* (Yandell and Shumard) with more or less dichotomous arms, have the opening toward the top, the former somewhat below the bulbous enlargement, and the latter almost at the very top, next to the terminal cluster of a few spiniferous plates (pl. 16, figs. 3–9). *Abrotocrinus unicus* (Hall), with the arms of *Pachylocrinus* somewhat modified but having a pentagonal stem, has the anus about midway (pl. 17, figs. 1–3); as have also *Scytalocrinus* and *Decadocrinus*, with their ten unbranched arms, the former with slender pinnules and the latter with strong armlets or ramules.[41] In *Aulocrinus*, with arms and pinnules of the *Decadocrinus* type, the opening is at about the same height, but projected from a lateral tube (pl. 19).

*Zeacrinus*, with heterotomous arms and short brachials, exhibits great variation in tube structure: *Z. elegans* of the Burlington has a rounded sac expanding upwards (pl. 21, fig. 2*a*); *Z. commaticus* of the Keokuk has the opening at the base of an elongated sac (pl. 22, fig. 3*a*); while the typical species, *Z. wortheni* of the Chester, has an altogether different form of sac, being a pyramid narrowing upwards to an apex, but having the opening about midway (pl. 23, fig. 2*a*).

*Hydreionocrinus*, with a highly distinctive spiniferous sac, and the opening in at least one species about midway, has no less than three different types of arms: *H. wetherbyi* nearly dichotomous, an intermediate stage; *H. depressus* strongly heterotomous, with the branching toward the inner side of the dichotom (pls. 25 and 26); and the British species, *H. woodianus*, with the branching toward the outer side of the dichotom. As if this were not a sufficient confusion of characters, it may be added that the two American species have respectively round and pentagonal stems.

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[41] North Amer. Crin. Cam., pl. 7, and herein, pl. 17.

In view of such lack of constancy in the characters of a single genus of this type, it is not certain that the position of the anal opening, as shown in the species above mentioned, will hold good for other species of the respective genera. This unusual development of the sac represents a hypertrophied condition of the organ, and structures modified by that sort of growth are apt to be more or less unstable. In fact the acquisition of large additions to the collection of the later Inadunate genera, since I discussed the Poteriocrinidae in 1911, has disclosed such an intermingling of characters which in other groups are regarded as distinctive, especially in the arrangement of anal structures, as to render the definition of some of these genera, containing a great number of species, perplexing and subject to exceptions.

Returning now to the consideration of the process by which the anal opening came to be upon the anterior side of the sac, it is not necessary to assume any extraordinary change in the organic development of the crinoid to produce this result. It depends merely upon the movements of the gut, which, as I have elsewhere shown,[42] are the cause of great morphological changes, and have produced many modifications in the external form of the calyx. Beginning in its primitive position in the ontogeny of the growing crinoid at one of the corners between the larval basals and orals, it migrates through a great variety of positions, so that the anal opening may issue and be finally fixed in the calyx of the adult crinoid at any point between the level of the radials and the middle of the tegmen. Its general tendency is towards the latter, that is, an upward growth, which finds expression in a greatly elongated central tube, such as that of the Batocrinidae. But this tendency may be diverted by unknown causes, and the course of the gut completely changed. This occurs for example in the Camerate genus *Siphonocrinus*, where in some species, instead of growing upward from its original posterior position, the gut is bent over and continued underneath the plates of the tegmen, passing completely over the oral portion to the anterior side of the calyx, where it opens out at or below the arm regions.[43] This is precisely what has happened in the Inadunate forms under consideration, except that the deflection and recurving occur at a later stage, involving not only the gut but also its tubular sheath of calcareous plates, and that instead of following a simple curvature continuing along a convex surface, the direction of the tube is more or less suddenly or abruptly reversed. With its upward growth thus arrested, the activity of the organ finds an outlet in different forms of expansion, or abnormal structures, at or near the point where the reversal occurs. As the tube in forms of this group is usually built up of plates arranged in longitudinal columns, it is not difficult to trace the course of these changes.

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[42] Crinoidea Flexibilia, pp. 67, 81, 86.

[43] North Amer. Crin. Cam., p. 210, pl. 19, figs. 3*a*, *b*, *c*; and herein, pl. 18, fig. 5.

The simplest case is seen in species of *Pachylocrinus*, such as *P. arboreus* or *P. scoparius* (pl. 16, figs. 3–7; 2), where the tube is greatly curved downward toward the anterior to an opening near or above midway; the walls along the line of contact are coalesced and the curved portion considerably swollen, but not rising beyond the limit of the arms. The longitudinal lines of plates forming the sac are distinctly seen in the swollen part.

In *P. florealis* (pl. 16, figs. 8, 9) the opening lies just below the distal end, and the tube is terminated by four spiniferous plates barely surmounting the arms.

In *Coeliocrinus ventricosus*, where the inflation of the sac is at the distal end and takes the form of a narrow-necked balloon, the longitudinal columns of plates which appear in several of the specimens testify that this is only the hypertrophied part of the tube incident to its reversal of direction (pl. 24, figs. 1–8). The anus has not been observed in this genus, but we know it must have been somewhere in the narrow neck below the inflated part.

*Aulocrinus*, which with its lateral spout appears to be the most aberrant form of all, really tells the story the best. This may be understood from the figures upon plate 19, made from a remarkable series of specimens in which the spout-like tube is shown in various positions. Here the longitudinal columns of plates are very conspicuous, being marked by sharp ridges, and it will be observed that the number of these columns when seen in a lateral view is considerably greater above the level of the spout than it is below. This results from the doubling of the tube upon itself, and the fusion of the apposed walls of the parts thus brought into contact; the process is completely shown by the two specimens in which the tube is exposed laterally (figs. 2 and 3). In figure 2 the ridged rows of plates can be traced continuously from the original tube into the reversed part.

From these it will be seen that the tube of *Aulocrinus*, instead of being curved and inflated as in the preceding examples, is abruptly reversed, as if it might have been bent, almost to the point of fracture, and the pieces bound together so that the distal end could continue to grow in the opposite direction from before. At the line where the reversal occurred incipient spines were developed, instead of a swollen sac—a modification which became dominant in *Hydreionocrinus.*

Thus the position of the anus on the anterior side depends upon the extent to which the tube grows downward after reversal, and if this is continued far enough the opening will be at the base of the tube, as in "*Scaphiocrinus*" *elegans;* and with the evidence afforded by the above mentioned examples it is clear that its position in all forms where located below the distal end may be accounted for.

The genera characterized by the Inflated Sac fall into a fairly well limited group forming a section of the subfamily Poteriocrininae as defined in the Zittel-Eastman textbook, edition of 1913. It has an extreme range from the earliest Lower Carboniferous through the principal subdivisions and into the Upper Carboniferous, and according to Wanner into the Permian. It reached its acme in variety and abundance in the Burlington and Keokuk, and in extravagance of form in the later formations. Coincident with the establishment of the mushroom form in the Chester, the group began to decline, and to be replaced by a series of genera in which the strong anal tube as a solid structure disappeared, and the anal plates were lifted out of the calyx until they no longer occupied a place within the ring of radials, and ceased to form an integral part of the calyx wall.

This series started with the long-lived *Eupachycrinus*, which began, as I now know, in the Keokuk with a rare and isolated species, and lasted through the Upper Carboniferous; and which, while retaining the strong radianal and anal plates of its predecessors, had only a remnant of the tube. The change progressed through *Cromyocrinus*, *Agassizocrinus*, *Ulocrinus*, *Erisocrinus*, and finally to *Encrinus* in the Trias, when all trace of anal structures in the calyx was lost.

The section with a tube, therefore, all having strong anal plates in the calyx to support it, includes the genera from *Poteriocrinus* to *Scytalocrinus* of the subfamily Poteriocrininae above mentioned, with some additions. In view of the close interrelationships of the genera comprising this group, the need of better description and illustration of some of them, and the presence of some new forms, it is desirable to give, along with the new matter, a general summary of their characters.

In this group, specialized as it is in regard to the ventral sac, there must be recognized, as already intimated, a considerable complexity and intermingling of characters, and the definition of genera is complicated by the occurrence of exceptions in regard to characters which in some other groups are considered to be of generic value. We simply have to select some character that appears to be dominant, and hold to it in spite of exceptions and uncertain correlations.

In the mode of arm branching, for instance, between a ray with two or more subordinate branches always borne on the same side of a main arm, as in *Hydreionocrinus depressus*—heterotomous—and one in which the arms divide by successive nearly equal bifurcations, as in *Pachylocrinus aequalis*—dichotomous— there is a clear distinction. The latter, with two or more full bifurcations, would give 8 or more arms to the ray. But if only 1 arm of the second bifurcation branches, that would give but 6 arms to the ray, making an intermediate condition which may occur under either category, and has to be dealt with according to circumstances, as for example in the heterotomous *Zeacrinus elegans*, or the dichotomous *Pachylocrinus arboreus*. So also the stem varies from circular to pentagonal, occasionally both in one species, and sometimes both in forms not otherwise separable generically. In the case of *Abrotocrinus* I have utilized Miller and Gurley's genus, separated only by this character, because it offers a convenient means of subdividing the unwieldy genus *Pachylocrinus*. It is not a very reliable character in this group. *Pachylocrinus aequalis*, with usually a round stem, has it sometimes pentagonal next to the calyx, and *Abrotocrinus unicus* has the stem both ways, but mostly pentagonal. Again, in *Zeacrinus*, the character most relied on is the very short brachials, which we call quadrangular, notwithstanding the fact that in various specimens some of the lower brachials are clearly cuneiform. Such exceptions, being part of the infinite variety in nature, must not disturb us.

The following table shows the relations of the genera as they appear in the light of present information:

### ANALYSIS OF THE GENERA

### Subfamily POTERIOCRININAE.

Section A. Poteriocrininae with elongated ventral sac, in which the anal opening is below the distal end, and at the anterior side. Anal plates, including radianal, strongly developed within the cup.

IBB 5: 2–3 anals in the calyx.
Radial facet round, not filling distal face of R.
  Sac tapering distally to an apex beyond the arms.......... Poteriocrinus.
Radial facet straight, filling distal face of R.
  Sac enlarging distally to a more or less rounded,
      nodose or spiniferous terminal.
  Arms branching on or beyond IIBr.
      Branching usually more than once.
    Dichotomous, uniserial, brachials cuneiform.
      Sac strong, club-shaped, occasionally spinose.

- Arms rounded and not abutting.
  - IBr not more than 2.
    - Column round------------**Pachylocrinus.** (**Olim Scaphiocrinus**).
    - Column pentagonal------------**Abrotocrinus.**
  - IBr more than 2. Arms branching unequally beyond them------------**Culmicrinus.**
    - Sac with strong median row of plates------------**Liparocrinus.**
- Heterotomous.
  - Brachials cuneiform or biserial, arms not abutting.
    - Sac balloon-shaped, exceptionally spiniferous.
      - Cup turbinate------------**Coeliocrinus.**
    - Sac mushroom-shaped, spiniferous.
      - Cup low, cup-shaped------------**Hydreionocrinus.**
  - Brachials quadrangular, uniserial.
    - Sac club-shaped or pyramidal.
      - Arms closely abutting------------**Zeacrinus.**
- Arms branching once on IIBr.
  - Arms not abutting; 4 to the ray, exceptionally 3 or 2.
  - Dichotomous: brachials cuneiform, fairly long------------**Ulrichicrinus.**
    brachials quadrangular, very short, arms heavy------------**Woodocrinus.**
- Arms not branching beyond IIBr.
  - 10 main rami, unbranched.
    - Brachials cuneiform.
      - Bearing strong ramules.
        - Cup usually depressed, with flat or concave base.
          - Anal opening directly through side of sac------------**Decadocrinus.**
          - Anal opening at end of lateral spout------------**Aulocrinus.**
      - Bearing ordinary pinnules.
        - Cup usually elongate, sometimes obconical to low bowl-shaped, rounded base.
          - Anal opening directly through sac------------**Scytalocrinus.**

## Genus PACHYLOCRINUS Wachsmuth and Springer

Plate 16

*Scaphiocrinus* HALL, Geol. Iowa, pt. 2, 1858, p. 550.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 112; pt. 3, 1886, p. 235.

*Pachylocrinus* WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 115; pt. 3, p. 242.—SPRINGER, New Amer. Foss. Crin., 1911, p. 145.—ZITTEL-EASTMAN, Textb. Pal., 1913, p. 222.

Mississippian; Kinderhook to Upper Carboniferous.

The reason for adopting this name for a majority of the great number of species described under *Scaphiocrinus* (*nomen nudum* because its type species belonged to the previously established *Graphiocrinus*) were set forth in my paper of 1911, above cited. It is one of the most prolific and long lived of Carboniferous types, containing, before removal of those with pentagonal stem under *Abrotocrinus*, upwards of 100 described species, ranging from the Kinderhook to the Upper Carboniferous. Although having typically dichotomous arms, it will include some intermediate forms in which there are one or two arms branching unequally to the inner side of the ray, provided these are rounded arms, not abutting as in *Zeacrinus.* Observance of this distinction will help to remedy some of the confusion in the descriptions. The type species, *P. aequalis* (Hall) of the Keokuk,[44] is shown by good figures in Geological Survey of Illinois (vol. 5, pl. 15, fig. 6), in Zittel-Eastman (1913, p. 222, fig. 323), and herein (pl. 16, fig. 1). It is a very abundant species, and specimens are to be seen in almost all collections. Sac and opening are similar to those of *P. arboreus*, but rarely seen.

Other good examples of this type are:

*Pachylocrinus* (*Poteriocrinus*) *concinnus* MEEK and WORTHEN, Geol. Surv. Illinois, vol. 5, 1873, pl. 14, fig. 3.

*Pachylocr.* (*Poteriocr.*) *jesupi* WHITFIELD, Bull. 1, Amer. Mus. Nat. Hist., 1881, pls. 1, 2. Syn. of *P. swallovi*, MEEK and WORTHEN, Geol. Surv. Ill., vol. 2, pl. 16, figs. 4*a*, *b*.

*Pachylocr.* (*Poteriocr.*) *coxanus* WORTHEN, Geol. Surv. Illinois, vol. 7, 1883, pl. 27, fig. 1. 12 arms to the ray.

*Pachylocr.* (*poteriocr.*) *spartarius* MILLER and GURLEY, Journ. Cin. Soc. Nat. Hist., 1890, pl. 7, figs. 1, 2, 3. 8 arms to the ray.

Notwithstanding the abundance of species belong to this genus, specimens showing the position of the anal opening are rare. To illustrate it I have used two species from the later formations, in one of which the opening is the nearest to the distal end of any I have seen.

### PACHYLOCRINUS AQUALIS (Hall)

Plate 16, fig. 10

*Scaphiocrinus aqualis* HALL, Supp. Geol. Iowa, 1860, p. 83.
Lower Burlington limestone; Burlington, Iowa.

I am figuring a characteristic specimen of this species, which is one of the most conspicuous of its formation, but has not before been illustrated. It attains a large size, some specimens being considerably larger than the one here figured, which I have selected for its excellent showing of the sac. I am glad of the opportunity to furnish an authentic figure of the species, to help clarify the confusion heretofore existing between the name and that of *P. aequalis* of the Keokuk.

### PACHYLOCRINUS ARBOREUS (Worthen)

Plate 16, figs. 3–7

*Zeacrinus arboreus* WORTHEN, Geol. Surv. Ill., vol. 5, p. 534, pl. 20, fig. 5.—SPRINGER, Amer. Geol., vol. 26, 1900, pl. 16, figs. 18–23.

Chester group, Ohara formation (formerly called St. Louis); Huntsville, Alabama.

This is a prolific species, found in good preservation, and represented in the collection by upwards of one hundred specimens. The rounded end of the sac as shown in the figures is constant in form and position in many specimens, and the opening just below it in several. The species belongs to the intermediate type of arm branching, which has caused it sometimes to be labeled *Zeacrinus*, while the resemblance in form of the inflated sac has also led to a reference to *Coeliocrinus*.

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[44] Boston Journ. Nat. Hist., 1861, p. 316.

### PACHYLOCRINUS FLOREALIS (Yandell and Shumard)

Plate 16, figs. 8, 9

*Cyathocrinus florealis* YANDELL and SHUMARD, Cont. Geol. Kentucky, 1847, p. 24, pl. 1, fig. 1.

*Zeacrinus florealis*, SHUMARD, Cat. Pal. Foss., 1866, pt. 1 p. 399.

Chester group, Glen Dean formation; Grayson Springs, Kentucky.

Three specimens of this rare species show the same peculiar small spiniferous termination of the sac above the ends of the arms, with the anal opening near the distal end. The wide difference in the structure of the sac between this and the preceding species emphasizes the extreme variability of this character.

## Genus ABROTOCRINUS Miller and Gurley

Plates 16, 17

*Abrotocrinus* MILLER and GURLEY, Journ. Cin. Soc. Nat. Hist., vol. 13, 1890, p. 30; 16th Rep. Geol. Surv. Indiana, 1891, p. 350.

Mississippian; Lower Burlington to Keokuk.

As already mentioned, I have utilized this genus, heretofore ranked as a synonym, to include those species of *Pachylocrinus* which have a pentagonal stem. It offers the medium of a convenient and much needed subdivision of that genus. The character is not a very reliable one, some intermediate forms having the stem pentagonal near the calyx and round lower down. The type species, *Abrotocrinus cymosus* Miller and Gurley,[45] from the Keokuk limestone of Canton, Indiana, is in its arm structure a beautiful example of the *Pachylocrinus* type. I am illustrating two species, one from the Upper Burlington which has never been figured, and one from the Keokuk, showing the median position of the anal opening.

### ABROTOCRINUS RUSTICELLUS (White)

Plate 16, fig. 11

*Poteriocrinus rusticellus* WHITE, Boston Journ. Nat. Hist., vol. 7, 1863, p. 505.

Upper Burlington limestone; Burlington, Iowa.

Another prominent Burlington species, not hitherto understood. There are several specimens even more conspicuous than the one here shown, but I am figuring it because enough of the sac can be seen on the opposite side, although too much shattered for drawing, to show that it was substantially like that of the other species figured, with the opening about midway.

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[45] Journ. Cin. Soc. Nat. Hist. 1890, pl. 5, fig. 2.

### ABROTOCRINUS UNICUS (Hall)

Plate 17, figs. 1–3

*Poteriocrinus* (*Scaphiocrinus*) *unicus* HALL, Boston Journ. Nat. Hist., 1861, p. 313.—MEEK and WORTHEN, Geol. Surv. Ill., vol. 5, pl. 15, fig. 5.—WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, pl. 7, fig. 6.

Keokuk limestone; Crawfordsville, Indiana.

One of the very prominent species of its celebrated locality, in which the sac with its midway opening is shown by numerous specimens, quite constant throughout. The pentagonal stem, at least next to the calyx, is distinct in more than fifty specimens.

### Genus CULMICRINUS Jaekel

Plate 18

*Culmicrinus* JAEKEL, Philogenie und System der Polmatozen, Pal. Deutschl., Berlin, vol. 3, 1918, p. 62. Untercarb. (Kulm). Pro *Poteriocrinus regularis* H. von Meyer, Herborn. To include *Poteriocr. missouriensis* Shumard.

Devonian to upper Chester.

Under this name Professor Jaekel has included a form which I have had set apart in my collection for many years as a new genus, containing species from at least four different formations. The dominant character is that it has more than two primibrachs, the number actually ranging from five to ten before the first bifurcation, after which the arms branch a few times at long intervals, with rather sparse pinnules borne on cuneiform brachials. The calyx is elongate, turbinate, with round stem. The remarkable thing about this form is its extremely large sac, rising to the full height of the arms, with the anal opening at the very base.

The form with extra primibrachs, varying considerably in other characters, ranges in America from the Chemung through the Waverly or its equivalent into the St. Louis, ending in the upper formation of the Chester. Several Chemung and Portage species have been described by Miss Winifred Goldring under *Liparocrinus* and three other new genera in the Monograph of the Devonian Crinoids just published by the State Museum of New York, and received too late for detailed consideration here. The species from the Waverly equivalent, or basal Mississippian, as yet undescribed, occurs in the form of imperfect impressions in western Pennsylvania. The other two are figured herewith.

### CULMICRINUS MISSOURIENSIS (Shumard)

Plate 18, fig. 3

*Poteriocrinus missouriensis* SHUMARD, Geol. Rep. Missouri, 1857, p. 188, pl. B, figs. *a–c*.
St. Louis limestone; St. Louis, Missouri.

One of the best known fossils in the St. Louis limestone, of which many good specimens have been found with the elongate ventral sac preserved, but it is only in the one herewith figured that the position of the anal opening is definitely fixed at the anterior side close down to the base. The species is notable for the slender, graceful contour of the crown.

In the Revision of Palaeocrinoidea (pt. 1, 1879, p. 114), Wachsmuth and Springer called attention to the fact that this species "differs from all others in this group in having a single arm to each ray, the first bifurcation taking place at the tenth or twelfth plate."

### CULMICRINUS ELEGANS (Wachsmuth and Springer)

Plate 18, figs. 1, 1*a*

"*Scaphiocrinus*" *elegans*, WACHSMUTH and SPRINGER, North Amer. Crin-Cam., 1897, pl. 7, figs. 1, 2.
Chester group, Glen Dean formation; Sloan's Valley, Kentucky.

I have figured at full length the type specimen, of which only a partial figure was given in 1897, in order to show the great size of the sac, this being the best known example of the lowest position of the opening. The tube is actually a little longer than is here shown, as it appears in a second specimen from the same locality otherwise not so perfect, which has some nodose plates to mark the change of direction. As in many of the genera of this group, the anterior ray differs from the others, in this case being unbranched.

## Genus AULOCRINUS Wachsmuth and Springer

Plate 19.

### AULOCRINUS AGASSIZI Wachsmuth and Springer

*Aulocrinus agassizi* WACHSMUTH and SPRINGER, North Amer. Crin. Cam., 1897, pl. 7, fig. 9.—SPRINGER, Amer. Geol., vol. 26, 1900, pl. 16, figs. 11, 12.
Mississippian; Keokuk group, Indian creek, Montgomery County, Indiana.

A monotypic genus founded on the species *A. agassizi*, figured as above without definition, or description, but based solely upon the extraordinary form of the ventral sac, which with its lateral spout exhibits a specialization without precedent among the crinoids. Aside from this the form is essentially that of *Decadocrinus* as to calyx and arms, but differs in the stem and cirri.

The species *Aulocrinus agassizi* is strongly characterized by sharp and prominent wrinkles upon the calyx plates; the angular and keeled brachials; the well defined pores at the sides of the hexagonal tube plates; and the sharp longitudinal columns in which these plates are arranged.' The stem is sharply pentagonal, and is provided with strong cirri, which are not shown upon the plate for want of space. The species is represented by ten specimens, six of which show the lateral spout. I am figuring a series of these to show all aspects of the remarkable structures, including a posterior view of the tube to its full length, and three views of the spout in such positions as enable us to trace the longitudinal ridges along the tube past the point where it doubles upon itself and branches backward into the spout. Especially instructive in this respect is the broken specimen (fig. 3), in which the ridges may be followed without interruption.

### ULRICHICRINUS, new genus

Plate 20

Upper Carboniferous; Pennsylvanian.

Between *Pachylocrinus*, *Scytalocrinus*, and *Woodocrinus*. Of a facies somewhat similar to that of *Scytalocrinus*, but has more than 10 long, slender, unbranched arms, bifurcating on the IIBr, both or only one, giving 4 or 3 arms to the ray. Brachials cuneiform, which distinguishes it from *Woodocrinus*, as also does the great relative difference in size of the arms. It has too many bifurcations for *Scytalocrinus* and not enough for *Pachylocrinus*. Calyx conical, spreading from the base about the same as in the turbinate Poteriocrininae generally. The tube has not been exposed, but from the elongate series of strong anal plates it is undoubtedly of the type of the related genera.

This genus is proposed for the reception of a species from the Morrow formation of Oklahoma, based upon specimens collected many years ago by Dr. E. O. Ulrich, while engaged in field work for the U. S. Geological Survey, and now placed in my hands for description by Dr. George T. Girty, in charge of Carboniferous researches for the Survey, which I have been unable to place under any of the described genera. It was, however, found to be congeneric with a well marked species from the Keokuk of Indiana described by S. A. Miller as *Poteriocrinus coryphaeus*, which while represented by numerous good specimens has always made trouble in the collections because it would not fit exactly under any known genus. With this addition the new genus is well distributed. I have pleasure in associating with this interesting form the name of the discoverer, my neighbor and colleague, Dr. E. O. Ulrich, of the United States National Museum. and United States Geological Survey.

### ULRICHICRINUS OKLAHOMA, new species

Plate 20, figs. 1, 2

Specimens large, crown about 10 cm. high. Calyx rather low, turbinate; IBr filling distal face of RR. Anal side with strong plates of Poteriocrinid type, with RA; post. B wide, narrowing to a very small apex, barely truncate, followed by a narrow anal plate *x*, with a large RA at the right. IBB rather tall and erect. BB almost as large as RR.

Arms long and deeply rounded, unbranched, pinnulate, of about uniform thickness to near the extremities, where they taper rapidly; they are uniserial, composed of extremely short, cuneate brachials, which in the median portion of the arm interlock to the stage of incipient biseriality, but become uniserial again towards the ends. Hence the pinnules springing from the long faces of the brachials are seen on successive ossicles in the middle portion and on alternate ossicles towards the distal ends. Stem strong, round, composed of alternate long and short columnals, contrasting greatly in length, the shorter ones being almost linear.

The species is to be compared with *Poteriocrinus coryphaeus* S. A. Miller, of the Keokuk limestone, which has flatter and broader arms, with longer brachials in the lower part, but nowhere tending to interlock. Post. B is not quite so narrow at the top, and is of smaller size, but the general type, number and mode of branching of the arms, are substantially the same.

There are two specimens of the new species, showing all the characters very clearly, except that the most complete one is damaged at the anal side. They were found in the same locality and horizon with the type of *Zeacrinus girtyi*, hereinafter described.

*Horizon and Locality.*—Upper Carboniferous. Morrow formation of the basal Pennsylvanian; near Crittenden, northeastern Oklahoma.

### ULRICHICRINUS CORYPHAEUS (S. A. Miller)

Plate 20, fig. 3

*Poteriocrinus coryphaeus* S. A. MILLER, 17th Rep. Geol. Surv. Indiana, 1891, p. 44, pl. 9, fig. 1.
Keokuk limestone; Canton, Indiana.

Abundant at Indian creek, Montgomery county, Indiana. *P. brittsi S. A. Miller*,[46] from Boonville, Missouri, may be identical with this, and if so would take the species. *P. amoenus* S. A. Miller,[47] is only a small specimen of *P. coryphaeus*.

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[46] Bull. 4, Geol. Surv. Missouri, p. 30.

[47] 17th Rep. Indiana, p. 45, pl. 9, fig. 6.

### Genus WOODOCRINUS De Koninck

Plate 26

*Woodocrinus* De Koninck, Rech. Crin. Carb. Belg., Supp., 1854, p. 4.—Wachsmuth and Springer, Rev. Pal., pt. 1, 1879, p. 124; pt. 3, 1886, p. 239.—Zittel-Eastman, Textb. Pal., 1913, p. 223.—Wright, Trans. Geol. Soc. Glasgow, vol. 16, 1917–18, pp. 364–391; Geol. Mag., vol. 61, 1924, pp. 270–9.

Mountain limestone to Hurlet formation; England and Scotland.

Much confusion in the literature was caused by the action of Wachsmuth and Springer in 1886, in referring to this genus a large number of American species previously ranged under *Pachylocrinus*, *Zeacrinus*, etc. Subsequent consideration has shown that the arrangmeent was not well founded, and it should be disregarded.

The genus, with a calyx substantially similar to that of other turbinate forms of the group, is strongly characterized by its few ponderous, rounded arms, composed of extremely short brachials with parallel sutures; they branch into mostly equal divisions somewhat irregularly, giving 4, 3, and occasionally only 2, arms to the ray. The plates of the anal side are unusually conspicuous and numerous, passing in a strong series up between the rays, which with the spreading arms indicates a large ventral sac of the expanding type—not yet observed, however.

The range of this genus as originally described from the mountain limestone of Yorkshire has been materially increased by the researches of James Wright in the Hurlet Limestone of Inverteil, and of Penton Linns, Scotland, where he finds it occurring abundantly, in probably two species different from the type. As the Hurlet formation represents in part the American Chester, passing up into the Coal Measures, this gives a stratigraphic range comparable to that of *Zeacrinus* and other genera of this group. For comparison I am figuring a characteristic specimen of the type species, *W. macrodactylus* De Koninck, from Richmond, England (pl. 26, fig. 19). There is also a good figure of it in Zittel-Eastman, 1913 (p. 223, fig. 324.)

### Genus ZEACRINUS (Troost) Hall

Plates 21, 22, 23

*Zeacrinus* Hall, Geol. Iowa, pt. 2, 1858, p. 144.—Meek and Worthen, Geol. Surv. Ill. vol. 2, 1860, p. 186.—Wachsmuth and Springer, Rev. Pal., pt. 1, 1879, p. 125; pt. 3, 1886, p. 243.—Bather, Edinb. Geol. Soc., vol. 10, 1911, p. 61.—Wright, Trans. Geol. Soc. Glasgow, vol. 16, pt. 3, 1917–18, 380.

Mississippian; Kinderhook to Upper Carboniferous; and Hurlet limestone, Scotland.

The characters of this genus as fully set forth by Wachsmuth and Springer in 1879 (Rev. Pal., pt. 1, p. 125) hold good in the main for the typical species, and my chief object in introducing it now is to illustrate more fully the form and structure of the ventral sac, which is especially notable for its variability. Later acquired specimens confirm the description of the sac given on page 127 of the work above cited as to some of the species, but exhibit great modification of it in others. They also enable me to show, what was not before known, the position of the anal opening, which notwithstanding the acuminate form of the sac as described, hinting somewhat at the possibility of a distal opening, proves to be strictly in accordance with the type characteristic of the other genera, namely, at the anterior side, about midway.

The differences in form of the sac bear some relation to the different geological positions of the species in which they occur, and the great stratigraphic range of the genus, from the Kinderhook to the Coal Measures, offers an excellent field for modification of such a special structure.

The dominant characters of the genus are the rather flat, closely abutting, infolding arms, meeting by linear margins, branching repeatedly but only from the outer arms of the ray toward the inner side of the dichotom; and the uniserial brachials, usually short, wide, and quadrangular, but with exceptions in the last respect in the lower part. This excludes nearly all species with rounded, divergent arms, and with wedge-shaped brachials, the inclusion of which by authors has been the cause of considerable confusion; but nevertheless allowance must be made for intermediate forms, some of which have to be included. It was formerly supposed that the genus required also a depressed cup, basin-shaped, with more or less concave base; but we are compelled to admit an exception in a well marked, otherwise characteristic species with an elongate, turbinate calyx, as was recognized in the diagnosis made by Wachsmuth and Springer. In fact, it seems after a final review of the material now available that the only stable character is the heterotomous arm-branching, with mostly uniserial, short and distally quadrangular brachials. Within this may occur: depressed or turbinate calyx; wide or narrow anal area; long or short RA; flat or rounded arms; club or balloon-shaped or pyramidal sac; round or pentagonal stem.

Variations in the structure of the anal side have caused some confusion in the attempt to formulate a generic diagnosis which would reconcile the differences between the earlier and later species. In the typical Chester species, *Z. wortheni*, the radianal is a long and narrow plate, often passing down between two basals almost to a contact with the infrabasals—a form and position so unusual that it has attracted special attention. But all species from the earlier formations are now known to have a short and broad radianal;

and it appears that in the very latest species of all, from the Pennsylvanian, the earlier form of radianal was resumed. Therefore such a range of variation in this character must be accepted for the genus.

So in regard to the arms. The typical species have the arms flat and closely apposed, touching all around by linear margins and forming a more or less smooth, rotund or ellipsoidal crown. But we are obliged to admit as exceptions others in which the arms are rounded and not in close contact, with axillaries prominent or nodose, as for instance, *Z. asper* Meek and Worthen.

Again, the sac typically is enclosed by the arms; but in some species, as *Z. commaticus* and *Z. girtyi*, it rises distinctly above them, and among the various species appears in the three different forms already mentioned.

As a general rule there is only the single axillary primibrach in the four rays other than the anterior, which regularly adds one or more brachials between that and the radial; but to this also there are a few exceptions.

*Zeacrinus* ranges through the entire Lower Carboniferous, beginning in the Kinderhook, culminating in the Chester, and passing up into the Pennsylvanian. It has hitherto been regarded as strictly an American genus, but it now appears prominently as a part of the remarkable crinoidal fauna brought to light in recent years by Mr. Wright from formations in Scotland equivalent to our Chester.

A few representative species will now be considered in detail:

### ZEACRINUS BURSAEFORMIS White

Plate 21, fig. 1

*Zeacrinus bursaeformis* WHITE, Proc. Boston Soc. Nat. Hist., vol. 9, 1862, p. 10.

Lower Burlington limestone; Burlington, Iowa.

A well-defined species, not before figured; represented by four good specimens, besides the type in the Museum of Comparative Zoology; differing from typical species by having the calyx in the form of an inverted, truncated cone, spreading directly to the arm bases, with turbinate base, instead of concave. Arms flat on the back, rather closely apposed, about 8 to the ray except the anterior which usually has 6. To the foregoing abstract from the original description may be added the following remark by the author:

> This species not only resembles *Zeacrinus* above the base, but possesses those characters which have been regarded as peculiar to that genus of having but two radials (R+IBr) to four of the rays, and a greater number in the anterior one; yet the body has the true form and development of *Poteriocrinus*.

That is, it is one of the striking exceptions to the type which upon a preponderance of characters must be held within the genus. It has a wide anal area, with posterior basal broadly truncate and a short and broad radianal, as is the case with all Burlington and Keokuk species. Form of the sac is unknown, but from the shape of the crown is probably similar to that of *Z. elegans*, which the species also strongly resembles in the short, quadrangular brachials, and mode of branching of the arms.

There is an undescribed species from the Keokuk limestone at Indian Creek, Indiana, represented by several specimens, with a turbinate calyx like *bursaeformis*, but otherwise a good *Zeacrinus*.

### ZEACRINUS ELEGANS Hall

Plate 21, figs. 2–4

*Zeacrinus elegans* Hall, Geol. Iowa, pt. 2, 1858, p. 547, pl. 9, figs. 1, 2.
Upper Burlington limestone; Burlington, Iowa.

The true *Zeacrinus* of the earlier type, with depressed calyx, post. B broadly truncate, RA short and wide, not passing down between BB. This structure is uniform in 28 specimens showing the anal side; and in a total of 43 specimens all have a single IBr, axillary, in four rays, and 3 or 4 in the anterior. There are 6 to 11 arms to the ray, usually 8 or 10. In this species we have the expanded, club-shaped sac, lying well within the arms, in marked contrast to that of the Chester species. I am figuring a good example of this, also another to show the range of variation in number of arms, and another of smaller size. The opening has not been observed. The other Burlington and most of the Keokuk species are true to this type, with variations as to minor details.

### ZEACRINUS COMMATICUS S. A. Miller

Plate 22, figs. 1–3*a*

*Zeacrinus commaticus* S. A. Miller, Geol. Surv. Missouri, Bull. 4, 1891, p. 36, pl. 5. figs. 10, 11.
Upper part Keokuk limestone; Boonville, Missouri.

A species remarkable for the introduction within the genus of a new type of sac, which rises above the limits of the arms, and has the anal opening at the base. The term "club-shaped" is especially well adapted to this sac, as it is in form a veritable war club, with a strong handle and knotted end. The species is abundant and strongly marked. It has the broadly truncate post. B, with short RA, of the earlier type, 49 specimens being all in that condition with little variation; and of these 37 have one IBr in four rays, and 12 have two IBr all around—an exceptional occurrence for the genus, but one which is repeated in the latest species. The projecting part of the sac with its rounded nodes is shown in many specimens, and its full length with the anal opening in two.

### ZEACRINUS WORTHENI Hall

Plate 23, figs. 1–8

*Zeacrinus wortheni* Hall, Geol. Iowa, pt. 2, 1858, p. 683, also p. 545.
Chester group, Okaw and Glen Dean formations; Randolph County, Illinois, Pulaski, Grayson, Todd and Breckinridge counties, Kentucky.

### ZEACRINUS MAGNOLIAEFORMIS (Troost) Hall

Plate 22, figs. 4–11

*Zeacrinus magnoliaeformis*, Hall, Geol. Iowa, pt. 2, 1858, p. 684, also p. 545.
Chester group, Gasper formation; Huntsville, Alabama.

The two typical species of the genus, in which is introduced the pyramidal form of sac, acuminate instead of rounded distally, which is most commonly associated with the genus, and which was the basis of the description of the sac in Revision of Paleocrinoidea, (1, p. 126). It is best shown in *Z. wortheni*, which is the more widely distributed and in better preservation. From this we now know the location of the anal opening, about midway, clearly shown in several specimens, from which the instructive illustrations are selected. In these species, especially *Z. wortheni*, is introduced the long, slender radianal, producing the narrow anal side which is so different from that of the earlier species.

As the two species are among the important fossils of their formations, and their names have been used rather indiscriminately by geologists in listing the fossils collected in various localities of the Chester area, it is very desirable to ascertain which is which.

There is nothing in Hall's formal description of the species to separate them. The principal discussion is on page 545, where it is said that *Z. wortheni* "has a narrow and less rotund base, with the cavity much less deep, and the subradial and first radial plates (BB and RR) proportionately shorter and the latter narrower, while the anterior ray has two intermediate radial plates." This might be true as between two individual specimens, but will not hold good for the numbers that are now in hand. In a note he says that *Z. wortheni* is distinct from *Z. magnoliaeformis*, "with shorter first radials, extending a little above the plane of the base, and arms much shorter and less robust." He gives a diagram of each, that of *Z. magnoliaeformis* from Troost's type; it does not show the anal side.

The diagram of *Z. wortheni* shows the anal side with post. B acuminate like the other BB, not connecting with *x* (next anal above), and RA narrow, passing low down between BB—that is, a narrow anal area.

The *Z. magnoliaeformis* type specimen is from Huntsville, Alabama, in what is now known as the Gasper formation of the upper Chester, where the species occurs numerously; while *Z. wortheni*, as found in several localities in Illinois and Kentucky, is from the next higher formation of the Chester, Glen Dean of Kentucky and Okaw of Illinois. Numerous specimens of both forms enable me to make a close comparison as to the corresponding characters.

From the Huntsville locality, Gasper formation, there are about 100 specimens, including 7 complete crowns. Measurement of these for height of crown and diameter of calyx at top of radials gives an average of 57 mm. height (ranging from 45 to 68), and 19 mm. diameter (17 to 21). Out of the total, 79 specimens have post. B broadly truncate, RA large and broad, producing a more or less wide anal area; 12 have post. B acuminate as in the type of *Z. wortheni*—a narrow anal area; and 9 are in an intermediate stage. Thus with 80 per cent of the specimens having post. B broadly truncate, it may be said in general that the earlier, Gasper, form has a wide anal area.

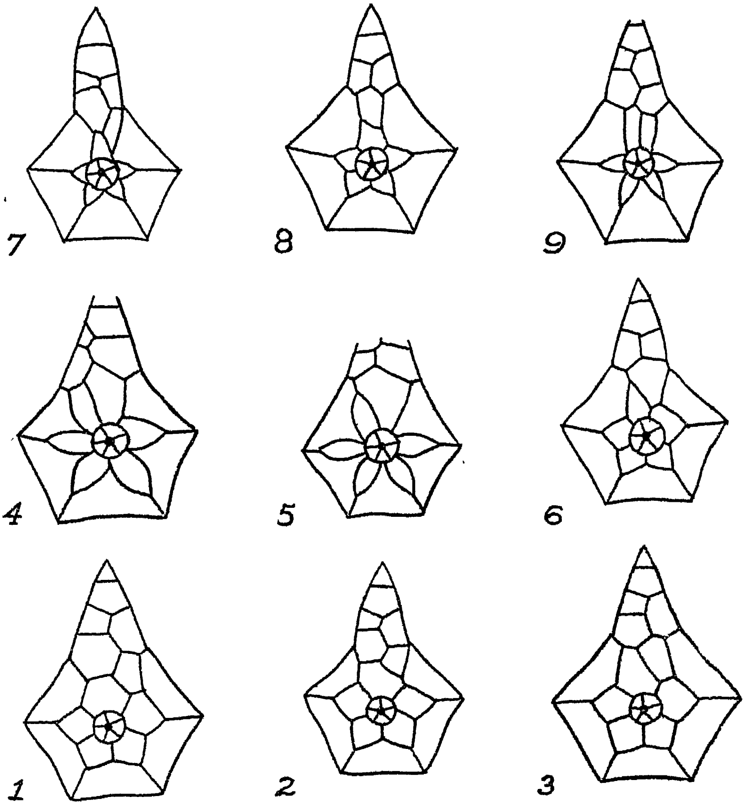
From the later formation, Glen Dean, at the most prolific locality, Sloan's Valley, Pulaski County, Kentucky, there are 65 specimens, among which are 22 complete crowns. Measurement of these yields an average of 30 mm. height (16 to 40) and 13 mm. diameter of calyx (7 to 17). Thus while on an average the absolute height of crown is about twice as great in *Z. magnoliaeformis* as in *Z. wortheni*, its relative height to the width of calyx is also much greater, being as 3 by 1 to 2.3 by 1. Of the Sloan's Valley specimens 37 have the post. B acuminate, with a narrow RA passing down alongside post. B almost to a connection with IBB. In the remainder the post. B is truncate to a varying extent, from 18 having a very narrow connection with the succeeding anal, being practically acuminate, to 10 in which the truncation is as broad as in the Huntsville specimens, with some intermediate stages; but in most of them the RA is an elongate plate, and the anal area in 85 per cent of the specimens should be classed as narrow.

These data seemed to furnish two good characters for distinguishing the species, until I was tempted to inspect the anal side of Troost's type by removing the hard matrix by which it was enclosed, and found that it has a pointed post. B, and thus falls under the exception instead of the general rule. Nevertheless, we are warranted by the great preponderance of the evidence in claiming the wide anal area as one of the characters for *Z. magnoliaeformis*, when correlated with the larger crown.

From the foregoing facts it results that the decisive difference between the two species as stated by Hall holds good in the greater length of crown in *Z. magnoliaeformis;* to which may be added that along with this it has usually larger basals, deeper basal cavity, and fewer bifurcations, these rarely exceeding two from the IIBr, giving 6 arms to the ray, while in *Z. wortheni* they usually run from 8 to 10. Each species is limited to its respective formation, and thus they are good horizon markers.

As in the earlier type, this one has uniformly an extra plate below the axillary in the anterior ray, but only the axillary IBr in the other four.

For comparison of the structures of the anal side in these species, and in those of the earlier type, I am giving a series of drawings showing the typical forms and the most notable variations observed in the course of this investigation (text-figures 1 to 9).



FIGS. 1–9.—ZEACRINUS; VARIATIONS IN ANAL AREA. 1. Z. ELEGANS; 2. Z. COMMATICUS; 3. Z. GIRTYI; 4, 5. Z. MAGNOLIAEFORMIS (SEE ALSO PL. 22, FIGS. 7–10); 6, 7, 8, 9. Z. WORTHENI (SEE ALSO PL. 22, FIG. 12, AND PL. 23, FIGS. 6, 7, 8)

Dr. Bather[48] has described from the Scotch Carboniferous of Fife some cups belonging to this genus under the name *Zeacrinus konincki.*

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[48] Trans. Edinb. Geol. Soc., vol. 10, 1911, p. 61.

Mr. Wright[49] has given further particulars of the occurrence of the genus in that region, which he finds to be quite abundant in two localities. He has noted variations in the anal area analogous to those which I have recorded for the two Chester species, and it is interesting to observe that out of 45 specimens examined by him 41 have the post. B acuminate with RA more or less elongate, all from one locality, and 3 have post. B truncate, with shorter RA, and are from a different locality. The similarity in this respect to the American species adds another significant fact toward the correlation of the two horizons, and we shall await with interest the description of the crowns to see what further resemblance is disclosed.

### ZEACRINUS GIRTYI, new species

Plate 23, figs. 9, 9*a*

This is the latest known occurrence of the genus, having a low cup, long truncate posterior basal, strongly heterotomous arms, partly uniserial; but to some extent with cuneiform brachials, and balloon-shaped ventral sac. The species is founded on a single very well preserved specimen from the basal Pennsylvanian of Oklahoma, of larger size than is usual in the genus, the length of crown being 6.5 cm.

Specifically it is exceedingly well marked by the fact that the heterotomy and the inflated sac are developed to an extent unknown in any other species. The rays divide on the second plate above the radial into two main and equal branches; each of these bifurcates further, but unequally—the outer branch of the ray continuing strong and dividing several times, giving off to the inner side of the dichotom successive branches, the lowest about one-third the thickness of the main branch at the point of bifurcation, and continuing simple to the full height of the ray. The differences in size between the outer arm and the inner ramules become less and less until the last division is about equal. This type of heterotomy is the same as that of *Z. wortheni* of the Chester, but it is more marked in this specimen than in any of that species, the taper of the main arms is more pronounced, and the bifurcations more numerous—there being seven here, whereas I have never seen more than five in the largest Chester specimen.

This species has also two primibrachs, so that the ray bifurcates on the second plate above the radial, instead of the first as is the rule in the genus except in the anterior ray, which usually has one or more additional brachials. In *Scytalocrinus* and similar genera closely allied to *Pachylocrinus* both structures are found, with many species of each; but in *Zeacrinus* and the closely related *Coeliocrinus* and *Hydreionocrinus* I do not remember to have seen before, except in a few specimens of *Z. commaticus*, an exception to the rule of a single primibrach to all the rays other than the anterior.

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[49] Trans. Geol. Soc. Glasgow, vol. 16, pt. 3, 1917–18, p. 380.

The ventral sac, which in other species except *commaticus* is only about half the height of the arms, is here of extraordinary size for the genus, approaching rather the structure of *Coeliocrinus* in this respect; it rises entirely above the ends of the arms, which are themselves unusually long and slender.

While the arm structure, as above stated, is like that of the Chester species, *Z. wortheni*, it is curious that the calyx of this species is more like that of the earlier forms of the Burlington limestone, such as *Z. elegans*, in having quite large and prominent basals instead of small ones almost concealed in the basal cavity, and also a short radianal.

On the whole, this may be termed an acmic species, recapitulating to some extent the characters found in the genus in earlier periods; and it doubtless represents the culmination of the genus, which has not hitherto been recognized later than the Chester.

The specific name of this remarkable species is given in honor of Dr. George T. Girty, in charge of Carboniferous researches for the U. S. Geological Survey, to whom I am indebted for the use of the material.

*Horizon* and *Locality*.—Morrow formation of the basal Pennsylvanian; near Crittenden in northeastern Oklahoma. Found by Dr. E. O. Ulrich associated with *Ulrichicrinus oklahoma*.

## Genus COELIOCRINUS White

Plates 24, 25

*Coeliocrinus* WHITE, Boston Journ. Nat. Hist., vol. 7, 1863, p. 499.

*Coeliocrinus*, subgenus of *Poteriocrinus*, MEEK and WORTHEN, Proc, Acad. Nat. Sci. Phila., 1869, p. 138.

*Coeliocrinus*, subgenus of *Hydreionocrinus*, WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 131.

Mississippian; Lower Burlington to Keokuk.

The prominent features of this genus are stated by the author as folows:

> First, the large inflated ventral sack, varying in size in different species, from four or five times the capacity of the calyx to ten or twenty times that capacity. It is widest at the top, in some cases extending above the tips of the arms—the lower part being contracted between the arms like the neck of a balloon—and joins by this the anal series.
>
> Second, the proportionally small calyx formed by the basal, subradial, radial, and first anal plates, which is so small as to render it certain that could not contain the necessary internal organs for the support of the other parts. These organs must have been located in the plated sack, which I have denominated the ventral sack; thus reversing their usual order of operation, as the mouth

was doubtless at the side of the neck, near the base of the arms. This aperture, however, has not been observed, although a separated sack of *C. dilatatus* has been carefully examined, together with more than half its neck, without the discovery of any aperture whatever, and four plates of the anal series seen, with no better result.

The genus was founded upon three species, *Poteriocrinus dilatatus* and *P. ventricosus*, previously described by Hall, and *Coeliocrinus subspinosus* of White, then described, all from the Burlington limestone. *P. dilatatus* was designated as the genotype. The descriptions of these species were unaccompanied by any figures, and none of them has since been illustrated, save by an incidental figure of the inflated sac of *C. ventricosus* given by Wachsmuth and Springer on plate 7 of the Camerata Monograph, and one of *C. dilatatus* by Whitfield (not of the type). in 1893. The arm branching is of the heterotomous type in principle, but not very well defined, there being usually seen only a single bifurcation beyond the IIBr, on the outer arm of the ray, the inner arm of equal size usually remaining unbranched. It is a sort of intermediate stage between dichotomy and heterotomy, which might fall under either term in some cases.

### COELIOCRINUS DILATATUS (Hall)

Plate 24, figs. 9–13

*Poteriocrinus dilatatus* HALL, Journ. Boston Soc. Nat. Hist., vol. 7, 1861, p. 300.

*Coeliocrinus dilatatus*, WHITE, Boston Journ. Nat. Hist., vol. 7, 1863, p. 501.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879,, p. 133.—WHITFIELD, Mem. Amer. Mus. Nat. Hist., vol. 1, 1893, pl. 3, fig. 18.

Lower Burlington limestone; Burlington, Iowa.

### COELIOCRINUS VENTRICOSUS (Hall)

Plate 24, figs. 1–8; plate 25, fig. 1

*Poteriocrinus ventricosus* HALL, Journ. Boston Soc. Nat. Hist., vol. 7, 1861, p. 301.

*Cocliocrinus ventricosus*, WHITE, Boston Journ. Nat. Hist., vol. 7, 1863, p. 501.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 133; North Amer. Crin. Cam., 1897, pl. 7, figs. 10*a*, *b*.

Lower Burlington limestone; Burlington, Iowa.

### COELIOCRINUS SUBSPINOSUS White

Plate 25, figs. 2, 3

*Coeliocrinus subspinosus* WHITE, Boston Journ. Nat. Hist., vol. 7, 1863, p. 501.—WACHSMUTH and SPRINGER, Rev. Pal., pl. 1, 1879, p. 133.

Upper Burlington limestone; Burlington, Iowa.

The three foregoing species agree in having a cup-shaped, expanding calyx, with a narrow conical base, as distinguished from typical *Hydreionocrinus* with a more or less broadly rounded cup and concave base; in all, the arms are composed of wedge-form brachials, and the branching is more or less of the heterotomous type, not always very distinct.

The first two, both from the lower Burlington limestone, have a true balloon-shaped ventral sac, with a narrow neck supporting a widely expanding bag above it, composed of numerous plates sharply sculptured or rising into angular nodes; whereas the third, from the Upper Burlington formation, having likewise a narrow neck, takes on the mushroom form, spreading out into a flattened disk, composed of rather numerous plates, some of which are produced into spines of variable length, like those of the later appearing *Hydreionocrinus.*

The differences between the first two as claimed by their author are rather slight, but between them and the third the distinction is very great, the spiniferous flattened top being constant in 15 specimens from the upper Burlington bed, as against about 25 from the lower in which the sac is always rounded and non-spiniferous; only two or three somewhat intermediate specimens have been seen. As between the lower bed species, the author notes that in *C. ventricosus* the second radials (IBr) are smaller than the first, and the arms more distinctly wedge-form, while in *C. dilatatus* the second radials are larger than the first and united at their lateral margins; and that in the former the sac is composed of large plates in the lower part and smaller in the upper, which is the reverse of the latter. Taking the specimens as they come these differences seem not to be very constant, but on the whole the plates of the sac at the distal part appear generally larger in *C. dilatatus* than in *C. ventricosus.*

As all three of these species were described without illustrations, paleontologists will welcome the publication of adequate figures now. I am giving photographs of the types of *C. dilatatus* and *C. ventricosus* now in my possession, formerly in the collection of Dr. C. A. White, together with some other specimens showing the characters of the species more completely; also of characteristic specimens of *C. subspinosus* as well known to the Burlington collectors. In none of the 40 specimens of the three species is the position of the anal opening disclosed, but it must be at some point below the inflated portion of the sac.

I am also figuring two specimens of the inflated sac of one or both the lower Burlington species from the equivalent horizon in southern New Mexico discovered by me in 1883,[50] showing the great geographical range of this highly specialized form.

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[50] Sprigner. On the Occurrence of the lower Burlington limestone in New Mexico, Amer. Journ. Sci., vol. 25, 1884, pp. 97–103.

*Horizon and locality.*—Mississippian, lower and upper Burlington limestone as above stated; Burlington, Iowa, and Lake Valley, New Mexico.

### COELIOCRINUS LYRA (Meek and Worthen)

*Zeacrinus lyra* MEEK and WORTHEN, Geol. Surv. Illinois, vol. 5, 1873, p. 432, pl. 1, figs. 11*a*, *b*.
Lower Burlington limestone; Burlington, Iowa.

This species has been referred to *Coeliocrinus*. The figures do not show the sac, but the description says that one specimen shows "a ventral prolongation nearly as long as the arms, somewhat expanded and covered with spines at the upper extremity." It has the strictly heterotomous arms of *Zeacrinus*, with numerous branches from the outer arm to the inner side of the dichotom; but the wedge-shaped brachials exclude it from that genus.

Another species, *Zeacrinus dubius* of Miller and Gurley,[51] from the Keokuk at Bono, Indiana, is almost a duplicate of *Coeliocrinus subspinosus*.

## Genus HYDREIONOCRINUS De Koninck

Plates 25, 26

*Hydreionocrinus* DE KONINCK, Bull. Acad. Royale Belgique, vol. 8, 1858, pt. 2, p. 13.—WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 129; pt. 3, 1886, p. 245.—BATHER, Trans. Edinb. Geol. Soc., vol. 10, pt. 1, 1911–12, pp. 61–76.—WRIGHT, Trans. Geol. Soc. Glasgow, vol. 16, 1917–18, pp. 364–383.—WANNER, Permischen Echinod. von Timor, 1916, pp. 150–166.
Lower Carboniferous to Upper Carboniferous.

The distinctive character of this genus, having the form of calyx and arrangement of anal plates substantially as in *Zeacrinus*, is the ventral sac, which at the distal end is transversely flattened like a mushroom, abruptly spreading beyond the tips of the arms and forming a low canopy composed of 5 to 35 or more plates; these are either a few, spiniferous and meeting towards the middle, or more frequently many nodose or flattened plates in the middle part, irregularly arranged, and bordered at the margin by a connected ring of spiniferous plates. This wide spreading sac is supported by a narrow tube, in which the anal opening is at the anterior side about midway, as now shown by three specimens. The cup is depressed, rounded, bowl-shaped, with the infrabasals, and sometimes basals also, sunken in a more or less deep cavity. This form of cup, and the constant presence of spines on the sac and on many of the brachial axillaries, distinguish the genus from *Coeliocrinus*, of which it may be the successor. The genus belongs typically to the later Lower Carboniferous, Hurlet in Britain and Chester in America, and ranges up into the Upper Carboniferous.

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[51] Journ. Cincinnati Soc. Nat. Hist., 1890, p. 44, pl. 7, figs. 7, 8.

The British species of the genus have been extensively discussed in recent years by Doctor Bather and Mr. Wright, with the benefit of fine newly discovered material obtained by the latter gentleman in the Hurlet limestone of Scotland, especially of the species *H. woodianus*, in which the structures of the ventral sac and arms are well shown. Along with a careful account of the generic characters, Bather,[52] with his usual lucid diagrams and figures, gives the most particular description yet published of the ventral sac and arms. Of the latter he says:

> Only one ramus, after each bifurcation, bifurcates again, and that is the one next to the middle line of the ray; all branches on the outer side continue single to the end.

This excellent description of the mode of arm branching has a special interest in relation to the American species. As to the ventral sac he says:

> No anal opening is yet known, but it probably lay at the base of the ventral sac on the anterior side, where Wachsmuth and Springer have found it in other fistulate crinoids.

Professor Wanner, in his work of 1916 on Permischen Echinodermen von Timor (pp. 150–166), has described and figured several species under this genus,[53] some of which seem to me to have more the habitus of *Coeliocrinus*, with the rounded inflated ventral sac.

### HYDREIONOCRINUS DEPRESSUS (*Hall from Troost*)

Plate 26, figs. 1–2

*Zeacrinus depressus* HALL, Geol. Iowa, pt. 2, 1858, p. 546.

*Hydreionocrinus armiger*, WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 31; pt. 3, p. 245.—WETHERBY, Journ. Cincinnati Soc. Nat. Hist., 1881, p. 325, pl. 9, figs. 1–4, 6.

Upper Chester; Pulaski and Grayson Counties, Kentucky.

### HYDREIONOCRINUS WETHERBYI Wachsmuth and Springer

Plate 25, figs. 4–12

*Hydreionocrinus armiger*, WACHSMUTH and SPRINGER, Rev. Pal., pt. 1, 1879, p. 131.—WETHERBY, Journ. Cincinnati Soc. Nat. Hist., 1881, p. 328, pl. 9, figs. 4–11.

*Hydreionocrinus wetherbyi* WACHSMUTH and SPRINGER, Rev. Pal., pt. 3, 1886, p. 245.

Upper Chester; Pulaski and Grayson Counties, Kentucky.

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[52] Notes on *Hydreionocrinus*, Trans. Edinb. Geol. Soc., vol. 10, pt. 1, 1911–12, pp. 61–76, with one plate.

[53] Now, in the second volume of his work, 1924, p. 250, referred to a new genus, *Cadocrinus*, which, for lack of radianal, does not strictly fall within this subfamily.

The characters of these two species must be sought chiefly in the work of Wetherby, above cited, where the descriptions are accompanied by excellent illustrations made from a series of finely preserved specimens of both, which exhibit the structure of the arms and ventral sac. Although himself in doubt as to their identity with the species previously described from imperfect material, he redescribed and figured them under the original names. This course as to the second species was not accepted by Wachsmuth and Springer, who changed it to *H. wetherbyi.* A large quantity of excellent material derived from Wetherby's locality enables me to confirm his observations in several particulars, and to add some newly discovered facts. These forms are of interest because they represent the culmination of the inflated sac in the later American Lower Carboniferous, and because the two species, although occuring closely associated in the same localities, are so completely distinct:

*H. depressus.* Basal cavity large, deep, rather pentagonal, involving most of BB, the IBB being buried at the bottom; stem pentagonal. IBr single, axillary and spiniferous except in the anterior ray, where one or two additional biserial pairs of brachials are interposed, and the bifurcation and spine are on the second or third brachial. Arms biserial, dividing on the third IIBr, followed by three or four divisions at intervals of about 4 brachials, always from the outer arm of the dichotom, the inner branch remaining single (the reverse of the British species), giving 34–42 ultimate branches, the number in the anterior ray being diminished. Summit of sac composed of a central area of numerous irregular plates surrounded by a peripheral band of plates terminated by spines projecting horizontally or a little downward, 20–35 plates in all.

*H. wethebyi.* Basal cavity small, shallow, almost restricted to the infrabasals; stem round; BB mostly visible. IBr single all around, axillary and spiniferous. Arms dividing on the sixth or seventh brachial above IAx, with not over two divisions at intervals of 7 or 8 brachials; usually only the outer branch bifurcating, giving about 26 final branches; all axillaries nodose or spiniferous; brachials cuneate, interlocking to biserial. Summit of sac without any inner set of plates, but composed entirely of spiniferous plates meeting in the middle, from 5 to 7 or 8 in number.

Thus the two species can be recognized from fragments only by either: (1) The base, with or without a section of the stem; (2) the calyx, if the anterior ray can be seen to the bifurcation; (3) the arms; or (4) the summit of the sac. *H. depressus* is the more abundant species, being represented in the collection by 170 specimens, and *H. wetherbyi*, much rarer, by 30. The characters above specified are constant throughout them all.

*Horizon and locality.*—Mississippian; Glen Dean formation of the upper Chester; Sloan's Valley, Pulaski County, and Grayson Springs, Kentucky. Most of the specimens of both species came from the same locality at Sloan's Valley, within a distance of a few hundred feet; but as the collection was made from the débris of a tunnel excavation, they may not have been derived from the same layer, although the matrix and lithological appearance are identical. Both species also occur at Grayson Springs in the same formation, but whether in the same layer is not known. They have not been recognized in other Chester localities.

For completion of the series under this group I am figuring some representative species of *Decadocrinus* and *Scytalocrinus.* The two genera exhibit variations of a well defined arm structure of two to the ray, unbranched; and while typical forms of the two are readily distinguished, there has been some uncertainty in the placing of certain species. As a general rule *Decadocrinus* has a depressed cup, with pentagonal stem, while that of *Scytalocrinus* is more or less elongate and turbinate, with rounded stem. But as to these there are exceptions; and the most reliable character in practice is found in the structure of the pinnules, those of *Decadocrinus* being large and well separated, resembling ramules, while those of *Scytalocrinus* are closely packed like regular pinnules. Both show good examples of the inflated sac. Those of the specimens which I figure are materially different in form, although both species have the anal opening about midway. But whether this difference is constant is not known, as the sac is too rarely found exposed to furnish a general rule. In both genera the anterior ray occasionally has but a single arm, making only 9 in all; and in both there may be either one or two primibrachs.

## Genus DECADOCRINUS Wachsmuth and Springer

*Decadocrinus* Wachsmuth and Springer, Rev. Pal., pt. 1, 1879, p. 119.
Devonian to Lower Carboniferous.

### DECADOCRINUS HALLI (Hall)

Plate 17, figs. 4, 5.

*Scaphiocrinus halli* Hall, Boston Journ. Nat. Hist., 1861, p. 308.
*Decadocrinus halli* Wachsmuth and Springer, Rev. Pal., pt. 1, p. 119.
Upper Burlington limestone; Burlington, Iowa.

An excellent example of the delicate Burlington forms of the genus. It only differs from *D. scalaris,*[54] from the same bed, which was designated by Wachsmuth and Springer[55] as type of the genus, by having a single primibrach instead of two.

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[54] Meek and Worthen, Geol. Surv. Ill., vol. 5, 1869, p. 421, pl. 2, fig. 10.
[55] Rev. Pal., pt. 1, p. 120.

### DECADOCRINUS TUMIDULUS (Miller and Gurley)

Plate 17, fig. 6.

*Cyathocrinus tumidulus* Miller and Gurley, Bull. 3, Ill. State Mus., p. 31, pl. 3, fig. 7.
*Decadocrinus grandis* Wachsmuth and Springer, North Amer. Crin. Cam., 1897, pl. 7, figs. 4, 5.—Springer, Amer. Geol., vol. 26, 1900, pl. 16, figs. 5, 6.
Keokuk limestone; Indian creek and Canton, Indiana.

A very striking species, numerously represented at its principal locality, and illustrating the development of the genus through the later formations. A specimen showing the anal opening about midway was figured in the Camerata monograph, erroneously designated as *D. grandis*.

## Genus SCYTALOCRINUS Wachsmuth and Springer

*Scytalocrinus* Wachsmuth and Springer, Rev. Pal., pt. 1, 1879, p. 116. Devonian to Upper Carboniferous.

### SCYTALOCRINUS VALIDUS Wachsmuth and Springer

Plate 17, figs. 7, 8

*Scytalocrinus validus* Wachsmuth and Springer, North Amer. Crin. Cam., 1897, pl. 7, figs. 2*a*, *b*, 3.—Springer, Amer. Geol., vol. 26, 1900, pl. 16, figs. 9, 10.
Keokuk limestone; Indian Creek Indiana.

A characteristic example of the genus, except in the rather depressed calyx; selected to show the anal opening in the sac midway, and the single arm as sometimes found in the anterior ray.

## Genus TIMOROCRINUS Wanner, 1912, 1916, 1924

*Timorocrinus* Wanner, Perm. Krin. Timor, vol. 2, 1924, pp. 54, 63, 181, 269.—Jaekel, Phylogenie und System der Pelmatozoen, 1916, p. 64.

The relation of this, the most abundant and heretofore the most mysterious of all the Timor crinoids, was satisfactorily settled by Professor Wanner in his latest discussion in 1924. He now recedes from his former view referring it to the Flexibilia, and concludes, following the opinion of Jaekel, that this remarkable genus, superficially unlike any other known crinoid, belongs to the Inadunate family Poteriocrinidae. It has a strongly inflated ventral sac, strengthened by numerous projecting longitudinal ridges of different grades, separated by corresponding furrows, in which the delicate arms and their branches were lodged, probably for protection. The sac is connected with the dorsal cup by means of a single strong anal, or proximal, plate meeting the greatly enlarged posterior basal. Basals are unequal, infrabasals fused and buried under the column. Anal opening is near the top of the sac, but on the posterior side instead of the anterior, which together with the absence of a radianal, differentiates it from the other genera in the group under consideration.

*Timorocrinus* is by far the most prominent crinoid of the Timor fauna, specimens being found by thousands, from which Wanner has described 11 species and 5 varieties.

## THE CRINOID FAUNA OF TIMOR

Professor Wanner's second volume (and also his work on the blastoids) has been published,[56] bringing that wonderful assemblage of unfamiliar forms up to a total of 41 new crinoid genera named, 18 hitherto known, all but one from other regions, 42 indicated by imperfect material but not named; and 189 species named plus about 50 only indicated. The 59 named genera are distributed as follows: Camerata, 6; Flexibilia, 10; Cyathocrinidae, 14; Poteriocrinidae, 25; Larviformia, 2; Insertae sedis, 2. Of the Camerata, the Rhodocrinidae and Batocrinidae are unrepresented, and the Actinocrinidae, Platycrinidae and Hexacrinidae are present with a few species. All the Flexibilia belong to the small and compact Lecanocrinidae except a single species, evidenced by one specimen, which falls under the Ichthyocrinidae. Including those forms not named, but which are all figured and described as far as possible, we have a probable aggregate of about 100 genera and 239 species. Besides these, there are 13 genera and 32 species of blastoids, all but 2 genera and 2 species new, and all belonging to families of distinctively Lower Carboniferous age.

A considerable part of the Timor crinoids might be classed among the "Unusual Forms," for 10 of the genera and 138 species are founded upon a single specimen, and many of those which are abundant are of types elsewhere wholly unknown. But I am only mentioning a few which bear some relation to the forms herein discussed. There are some general characteristics of the fauna, however, to which a brief allusion may be made.

The predominant element consists of types which point to a life in strongly moving water, essentially a reef life, resulting in a number of striking modifications and departures from the normal structures, shown by the great prevalence of variations, malformations, and special adaptions to the environment, such as the slanting position of the calyx upon the stem; compact, rounded forms with thick calyx plates; short, simple, infolding arms, many of them fitting snugly into furrows as a means of protection. The highly organized, complex forms with long, pliant stems and delicately constructed arms and pinnules, so characteristic of the great Silurian and Carboniferous crinoid deposits of Europe and America, are but little represented in Timor; although there were evidently some areas of quiet water protected from wave action, as on the lee side of reefs, which accommodated species with thin stems, especially the multitudes of blastoids, of which there have been collected, belonging to a single genus, upwards of 60,000 specimens. The crinoids, now largely imbedded in marls and volcanic tufas, have been much broken up by action of rough water, transportation from their original habitat, and by subsequent geological movements, so that complete specimens are rare; and many strong isolated stem fragments are present, indicating the existence of forms of which the other parts have disappeared.

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[56] Die Permischen Krinoiden von Timor, pt. 2, 1924, 348 pp., 22 plates. The Hague. Die Permischen Blastoiden von Timor, 1924. The Hague.

The most remarkable modification caused by the life conditions was the reduction and loss of arms, thought to be due to the action of currents bringing the food directly to the stationary crinoids without the aid of moving arms, which through atrophy from disuse were reduced in number, even finally to complete suppression. There are 9 genera of such forms occurring here, two of them before described from other areas, while 7 are new and restricted to Timor. Two of these have 3 arm-bearing rays, three have only one, and in the remaining four all the arms have disappeared. The latter must represent a persistent larval condition, being composed of the primative elements of the crinoid skeleton, namely, basals and orals, with the addition of well developed infrabasals, and in one case of rudimentary radials. Some of the specimens bear a striking resemblance to the larval *Comactinia*, as illustrated on plate B of my work on the Crinoidea Flexibilia.

While the absence of arms is the predominating character, the four genera are separated by differences readily recognized, which emphasize the extreme modifications produced by the conditions under which they existed. For example, one of the genera, appropriately named *Embryocrinus*, has radials upon which the arms might potentially have grown, but did not; they are very small, rudimentary, and not in contact—substantially as in the early stage of the *Comactinia* larva. But in the other three there is no trace or vestige of radials, the interval between basals and orals, where the radials normally originate, being shut off by the close contact of those plates. In one of these, *Lageniocrinus*, the orals are interradial in position, in line with the basals—being the normal location in crinoids generally—which theoretically would leave a place at the corners for arms to develop; but in the other two, *Coenocystis* and *Acariaiocrinus*, they are radial, alternating with the basals—an unprecedented arrangement which would exclude every possibility, actual or theoretical, of the development of arms. Two of the most striking of these forms, *Monobrachiacrinus* with one arm, and *Embryocrinus* armless, are very abundant, indicating a wide extent of the conditions and their effects; while the others are rare. One of the two genera with aberrant orals, *Coenocystis* Girty, already known in America, is represented by a single specimen, which might be attributed to malformation; but of the other there are two well defined specimens in which the exceptional character is clearly shown, leaving no doubt of its being a definite structure.

Evidently this extreme specialization marked the end of the line, for these armless crinoids left no successors to our knowledge, either in the prolific deposits of the Mesozoic, or among the numerous species which inhabit the present oceans. But there are certain other forms which seem in a remarkable way to anticipate Mesozoic types; for example, the genera *Prophyllocrinus* and *Proapsidocrinus*, which may well be taken as the ancestors of the Jurassic genera from which their names are adapted. Equally remarkable as a survival, or a prophetic type, or more probably as an independent example of adaptation to a reef life, is *Palaeholopus*, which like *Edriocrinus* of the Devonian, *Cyathidium* of the Chalk, and *Holopus* of the present seas, had no stem, but was attached directly by the greatly modified base to rocks or corals at shallow depths.

The age of the Timor crinoids and blastoids, held by the author to be Permian, remains a perplexing question, owing to the presence of such a large element of distinctly Lower Carboniferous affinities. This was briefly discussed by me,[57] and somewhat further since.[58] While it is admitted that much remains to be learned concerning the geology of Timor, yet in view of the concurrent opinion to the same effect of the other authors who have studied the associated invertebrate fossils, it would seem that the Permian age of the formation as now determined should be accepted.

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[57] Smithson. Misc. Coll., vol. 76, 1923, p. 30.

[58] Amer. Journ. Science, vol. 8, October, 1924, p. 325

## EXPLANATION OF PLATES

Enlargement, if any, of the drawings is indicated by the sign at the end of the paragraph. Unless so noted the figure is of natural size. All the specimems figured, except as otherwise stated, are in the author's collection, now in the United States National Museum.

### PLATE 1

All figures not otherwise noted natural size

Page

**MYELODACTYLUS CONVOLUTUS** Hall____________________________ 8

FIG. 1. A very large specimen, with broadly curved stem beyond the proximal coil, showing the closely packed cirri paired on successive parallel columnals in the bilateral part, some of the noncirriferous proximal coil with circular neck leading to the crown, which is imperfectly exposed from beneath the enveloping cirri.

2. Another specimen, with stem broken off beyond the close coil, and a few cirrals and part of the neck exposed. × $\frac{3}{2}$.

3. Another typical, but smaller specimen, with much of the broad curve intact, and cirri converging at center of close coil completely enveloping the crown.

4. Fragment of bilateral part of stem seen from the outer side of curve, showing the longitudinal sutures. × $\frac{3}{2}$.

5. Another fragment from inner side of curve. showing the cirrus-facets at each end of successive columnals. × $\frac{3}{2}$.

6. Joint-face of a columnal from median bilateral part of stem. × $\frac{3}{2}$.

7. Specimem from Laurel limestone, St. Paul, Ind.; showing close coil and beginning of broad curve of stem. Cirri not preserved, but their facets are to be seen like those in the fragment following.

8. Fragment from same locality, seen from inner side of curve, with cirrus-facets on each columnal. × $\frac{3}{2}$.

All except 7 and 8 are from the Rochester shale, Niagaran; Lockport, New York.

**MYELODACTYLUS BREVIS**, new species__________________________ 10

FIG. 9. The only specimen; a nearly complete coil tapering to the distal end, with cirri paired on each columnal and converging to the center. × $\frac{3}{2}$.

9*a*. Distal outer view of same, showing taper almost to the end. × $\frac{3}{2}$.

Niagaran, Brownsport limestone: Decatur County, Tennessee.

Page

**MYELODACTYLUS FLETCHERI** (Salter) 10

FIG. 10. Salter's type, in the museum of Cambridge University, England, by which the true nature of the fossil was first shown. Drawn from a cast in which the details of calyx and arms are indistinct, but the composition of stem and cirri is evident.

11. A specimen in the British Museum, showing the form, proportions and mutual relations of stem, cirri and crown. By permission of the Keeper of Geology.

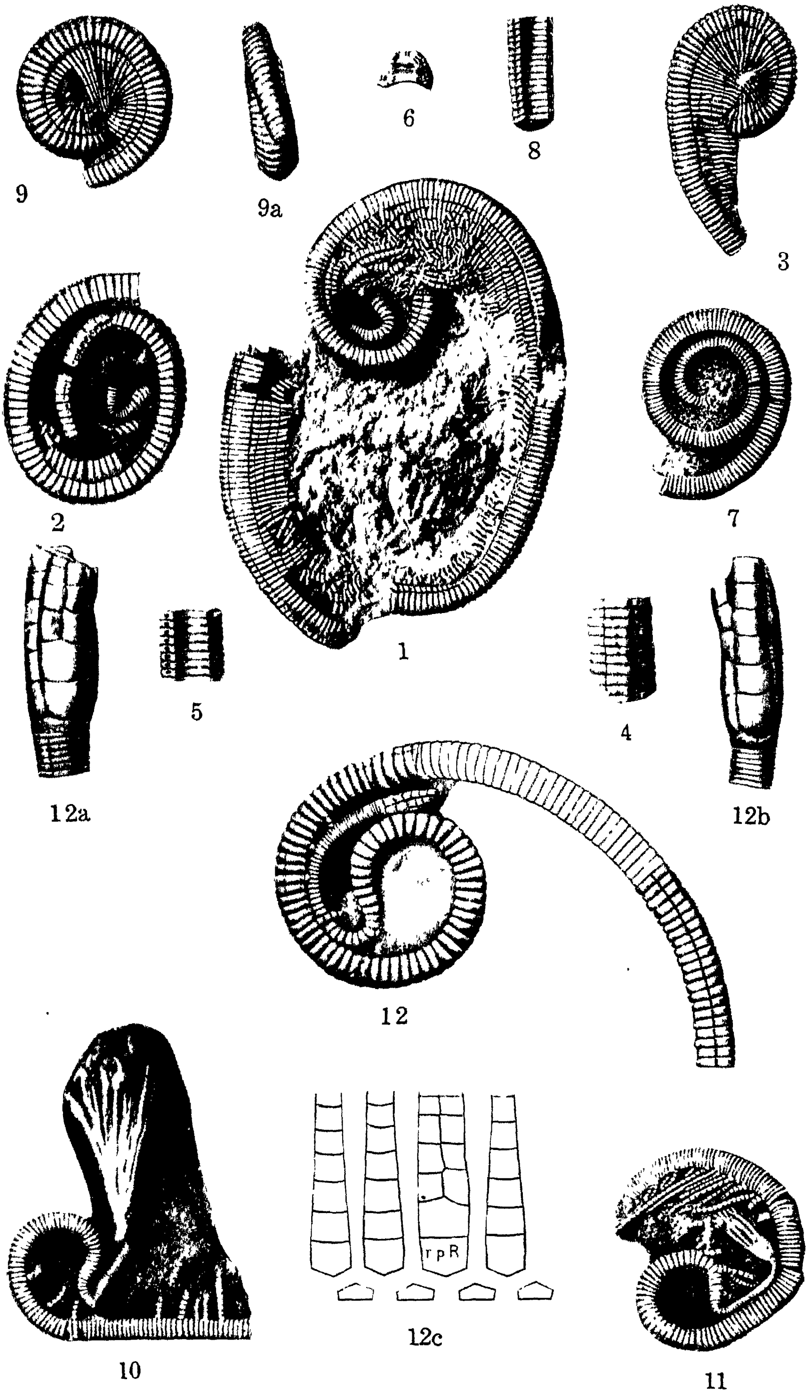
12. A specimen in the author's collection, of which the crown is detachable for inspection at all sides, showing that it has only 4 radii. × 2.

12*a*. Calyx of same from posterior side, with anal tube resting upon the left shoulder of r. post. Rs. × 6

12*b*. Calyx from anterior side. × 6.

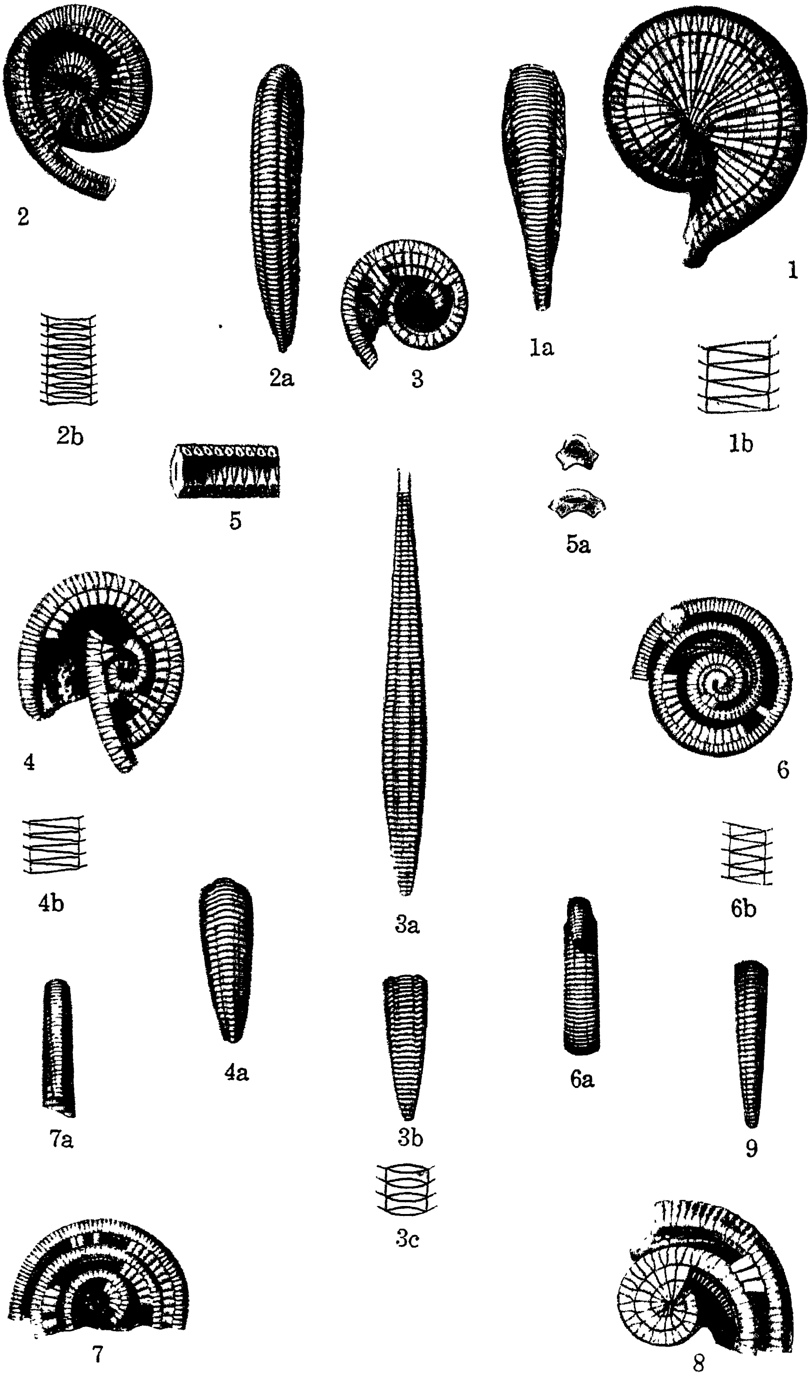
12*c*. Diagram of calyx and arms.

Silurian, Wenlockian; Dudley, England.



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGES 97, 98



Unusual Forms of Fossil Crinoids

For explanation of plate see pages 99, 100

## PLATE 2

All figures not otherwise noted natural size

Page.

**MYELODACTYLUS AMMONIS** (Bather) ________________________ 10

FIG. 1. A close coil, with stem tapering to a point; cuneate interlocking columnals with a cirrus from the broad end of each; cirri converging to center, completely enveloping the crown. $\times \frac{3}{2}$.

1*a*. The same specimen, seen from outer curve, showing the rapid taper of stem to a narrow distal end; longitudinal sutures not visible in this specimen. $\times \frac{3}{2}$.

1*b*. The alternate succession of columnals in outline—var. *alternicirrus*.

2. A similar specimen (figure not enlarged), with hour-glass shaped columnals bearing a cirrus at each end, and lenticular, non cirriferous ossicles interposed.

2*a*. The same seen from the outer curve, tapering to a point, and with longitudinal sutures strongly developed. $\times \frac{3}{2}$.

2*b*. The paired succession of cirri in outline—var. *bijugicirrus*.

3. A small specimen of similar type to last, with strong distal taper. $\times \frac{3}{2}$.

3*a*. The outer side of same specimen as it would appear if stretched out straight; to show the great relative breadth in the middle region, narrowing both ways, and ending distally in a point; outer longitudinal sutures strong. $\times \frac{3}{2}$.

3*b*. The distal end of same. $\times \frac{3}{2}$.

3*c*. The succession of columnals in outline, with paired arrangement of cirri—var. *bijugicirrus*.

4. A similar specimen, with alternate cuneate columnals; small part of proximal coil is shown. $\times \frac{3}{2}$.

4*a*, *b*. The tapering distal end, and the succession of columnals in outline—var. *alternicirrus*.

5. Part of a remnant of two coils, from the inner side of the innermost coil, showing the form and arrangement of columnals for the paired cirri—var. *bijugicirrus*. $\times \frac{3}{2}$.

5*a*. Transverse view of the fractured section of the two coils, the upper one being near the distal end, therefore thicker and narrower than the lower. $\times \frac{3}{2}$.

All the foregoing are from the Brownsport limestone, Niagaran; Decatur County, Tennessee.

6. Specimen with three involute coils, tapering to a narrow distal end. The cirri have mostly fallen away, exposing the proximal evolute coil with the slender, circular neck leading to the faintly outlined crown lying along the concave side of the middle coil.

6*a*. Outer curve of same, showing distal end and longitudinal sutures.

Page

FIG. 6*b*. The succession of columnals—var. *alternicirrus*. 10

7, 7*a*. Similar views of a fractured specimen of same type, showing form and proportions of first cirrals on three successive coils—var. *alternicirrus*.

8. Remnant of a fractured specimen associated with the two preceding in the same layer, having paired cirri—var. *bijugicirrus;* a portion of the circular neck and of the crown are visible. × $\frac{3}{2}$.

9. The tapering distal end only of a stem with extremely slender termination. × $\frac{3}{2}$.

The last four specimens (6–9) are from the Waldron shale, Niagaran; Newsom, Tennessee.

## PLATE 3

All figures not otherwise noted natural size

| | Page |
|---|---|
| **MYELODACTYLUS EXTENSUS**, new species | 14 |

FIG. 1. A large specimen with stem extended about 8 cm. beyond the close coil, nearly straight, not terminating in a point. Has cirri on alternating, cuneate columnals.

1*a*. The succession of columnals—var. *alternicirrus*.

2. Another large specimen with stem extended about 5 cm. beyond the deviation from the close coil, and beginning to diminish at point of fracture; the proximal reverse curve is seen. Has paired cirri on hour-glass shaped columnals.

2*a*. The succession of columnals—var. *bijugicirrus*.

3. Another specimen with stem extended about 6.5 cm. beyond the close coil, tapering near the end where it seems to terminate in small roots of radicular cirri. Has paired cirri.

3*a*. The succession of columnals—var. *bijugicirrus*.

4, 4*a*. A small specimen with some alternating cirri in place, and outline showing succession of columnals—var. *alternicirrus*. $\times \frac{3}{2}$.

5. A large specimen with very small close coil, and the loose coil, partly restored, extended for about 12 cm. beyond the place of deviation, and not yet terminated. Parts of a few cirri are in place. Columnals of var. *bijugicirrus*.

6. Smaller specimen with much of extended stem broken off. Proximal coil is seen, with reversed curve of the circular neck, followed by the crown, of which the calyx is indistinct. Columnals of var. *alternicirrus*. $\times\frac{3}{2}$.

7. Large specimen with incomplete stem for about 7 cm. beyond close coil. Polished section obtained by grinding down to the axial canal, showing the proximal coil, neck, and crown in outline, with scattered cirrals in some places. Columnals of var. *bijugicirrus*.

8, 8*a*. Reverse sides of a specimen with only the close coil remaining, having the cirri complete, converging at the center. Columnals of var. *bijugicirrus*.

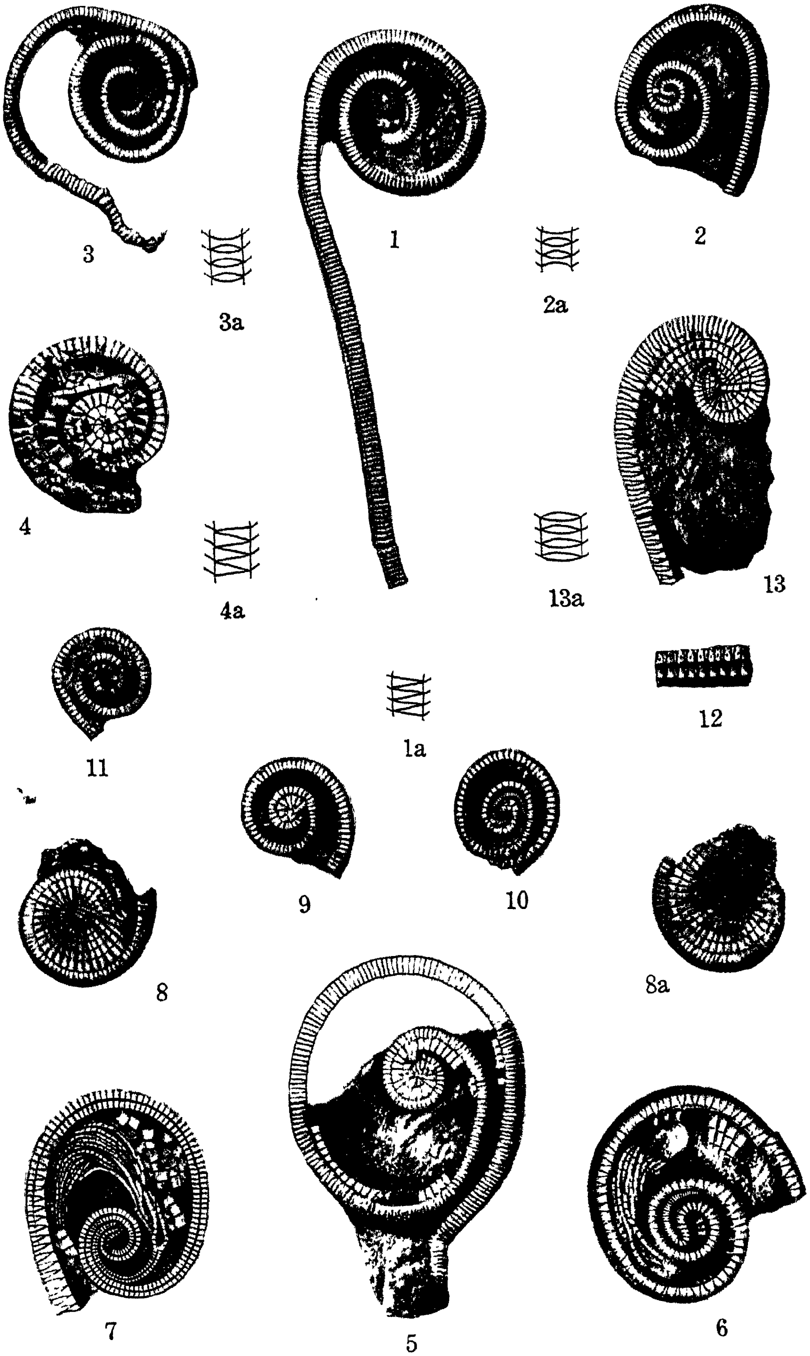
9, 10, 11. Three small specimens with stems broken off, not far beyond the close coil. All of var. *alternicirrus*.

12. Fragment of stem from St. Paul, Indiana, showing both paired and alternate cirri in the same specimen. $\times \frac{3}{2}$

13. A specimen from the Wenlockian at Dudley, England, with paired cirri in place at the closed coil, and stem extended far beyond that region, not yet diminishing distalwards.

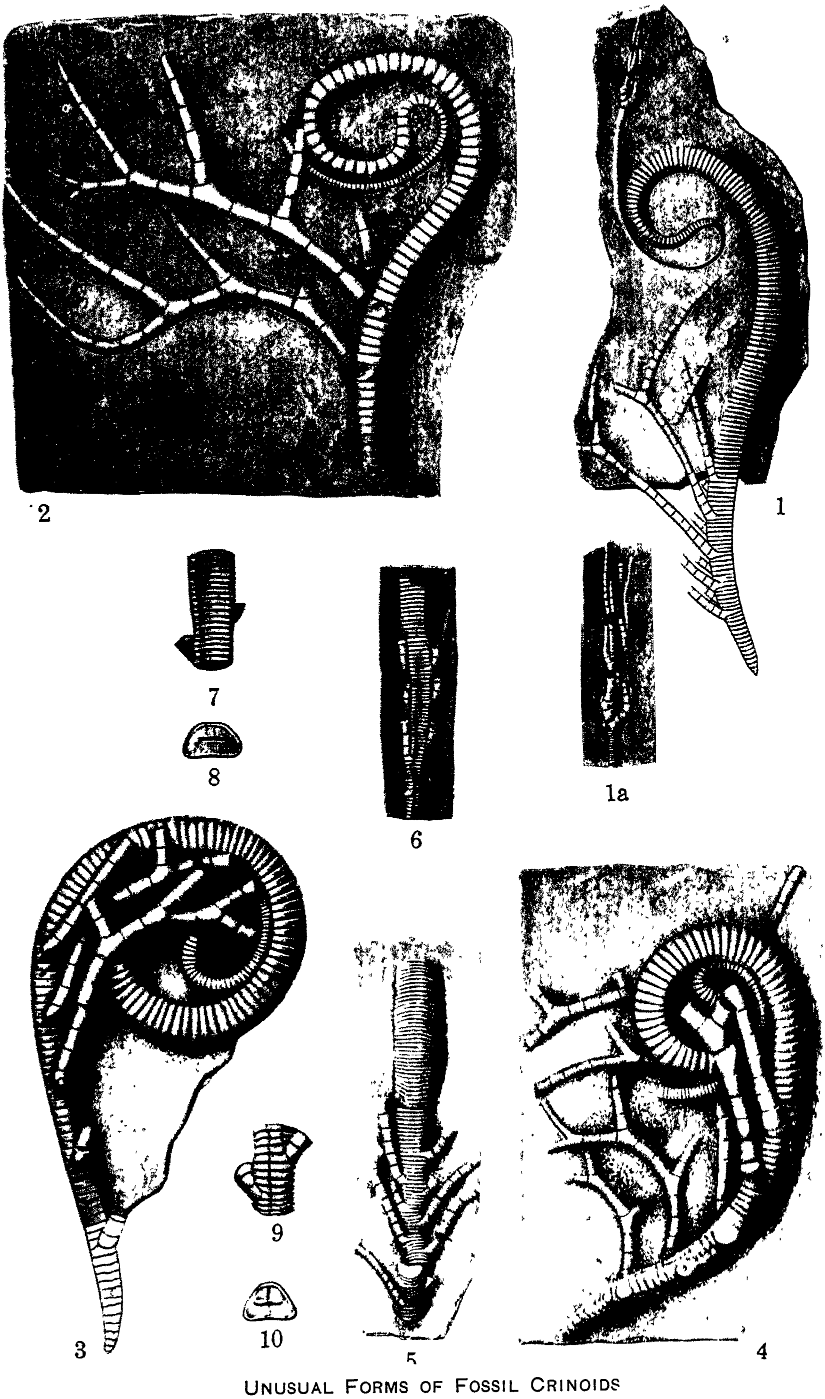
13*a*. The succession of columnals—var. *bijugicirrus*.

All except 12 and 13 are from the Brownsport limestone, Niagaran: Decatur County, Tennessee.



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 102



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 103

## PLATE 4

Figures not otherwise noted natural size

Page

**MYELODACTYLUS BRACHIATUS** Hall ........................ 16

FIG. 1. Specimen with the crown preserved, showing the extreme length and slenderness of the proximal neck leading to it at the end of the reversed curve, and outside of the main coil of the stem. Some of the branching cirri are shown, limited to the distal region. × $\frac{3}{2}$.

1*a*. The crown of same, further enlarged. × 3.

2. A small specimen, with nearly complete stem extending to near the calyx, where the slender neck is broken off outside the main coil, as in all specimens except the preceding. It shows the great relative size and repeated branching of the cirri, which are almost as long as the thickened part of the stem. × 3.

3, 4. Two specimens with neck similarly broken off, showing the numerous branching cirri in various positions rising from the distal region, enveloping the proximal coil like a fringe. Fig. 3 shows the complete stem, tapering to a point at the distal end. × 2.

5. A very large specimen seen from outside of curve, showing the longitudinal sutures, and alternate arrangement of the rounded cirri arising from back of stem, and limited to the distal region. Columnals of this specimen are 6 mm. wide at the back.

6. Distal portion of a broken specimen seen from the inner side of the curve.

7. Fragment from above the upper limit of cirri, seen from inner side of curve. × $\frac{3}{2}$.

8. Transection of stem at about same position as last, showing form of axial canal. × $\frac{3}{2}$.

9. Fragment toward the distal end, seen from outer side of curve, showing origin of cirri at back of stem. × $\frac{3}{2}$.

10. Transverse view of joint-face at about same level, showing the relative narrowing and thickening of the stem approaching a circular form at the termination. × $\frac{3}{2}$.

Niagaran, Rochester shale; Lockport, New York.

## PLATE 5

Figures not otherwise noted natural size

Page

**MYELODACTYLUS NODOSARIUS** Hall............................ 20

FIG. 1. One of Hall's types (Pal. N. Y., vol. 3, pl. 5, fig. 5), showing the great size of the ponderous cirri compared with the smaller stem, and the bulbous terminal at distal end, seen from outer side of curve.

2. A similar specimen in which the terminal bulb ends in a point.
3. Another type (idem, pl. 6, fig. 1), seen from inner side of curve, showing the full length of cirri swollen in the middle.
4. Specimen showing still greater swelling of the cirri.
5. Specimen showing considerable length of the cirrus-bearing part of the stem.
6. Distal end of stem, showing relative size of terminal bulb, and first cirrals. Author's collection.
7. The same structures with addition of several cirri, showing small size of first cirrals.
8. Inner side at distal end, showing terminal bulb, small size of stem and mode of attachment of cirri. Collection Yale University.

Helderbergian, New Scotland formation; Schoharie County, New York. All the specimens not otherwise noted are in the New York State Museum, Albany.

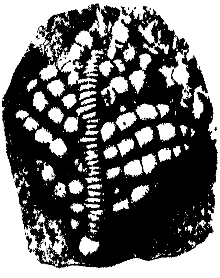
**MYELODACTYLUS SCHUCHERTI**, new species.................... 21

FIG. 9. The only specimen, with both distal and proximal portions broken off, leaving one coil of the main, crescentic region of the stem, followed by the reverse curve, and the very robust proximal neck; several cirri are in place, paired on successive columnals. × 2.

9*a*. Reverse side of same, showing the same structures. Note the peculiar arrangement of columnals in the exposed part of the proximal neck. × 2.

9*b*, 9*c*. Details of columnals in the part of the neck towards the calyx; side and top views, further enlarged. × 6.

Helderbergian, Linden formation; Benton County, Tennessee. Coll. U. S. National Museum.



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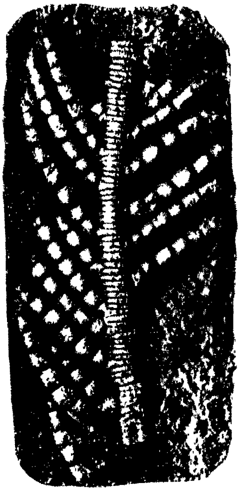

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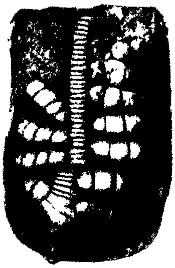

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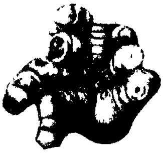

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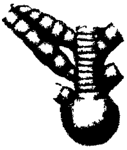

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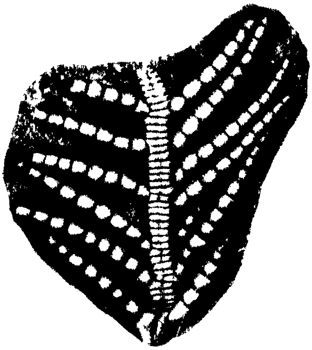

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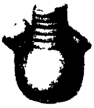

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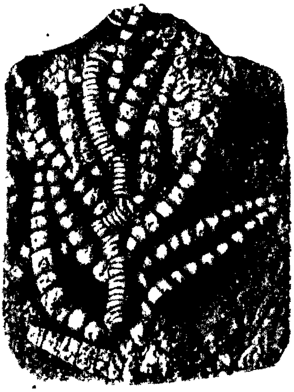

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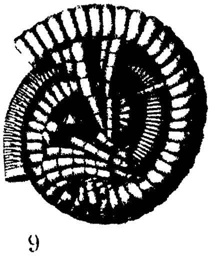

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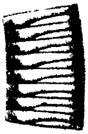

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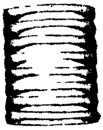

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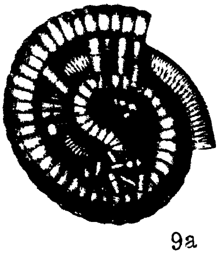

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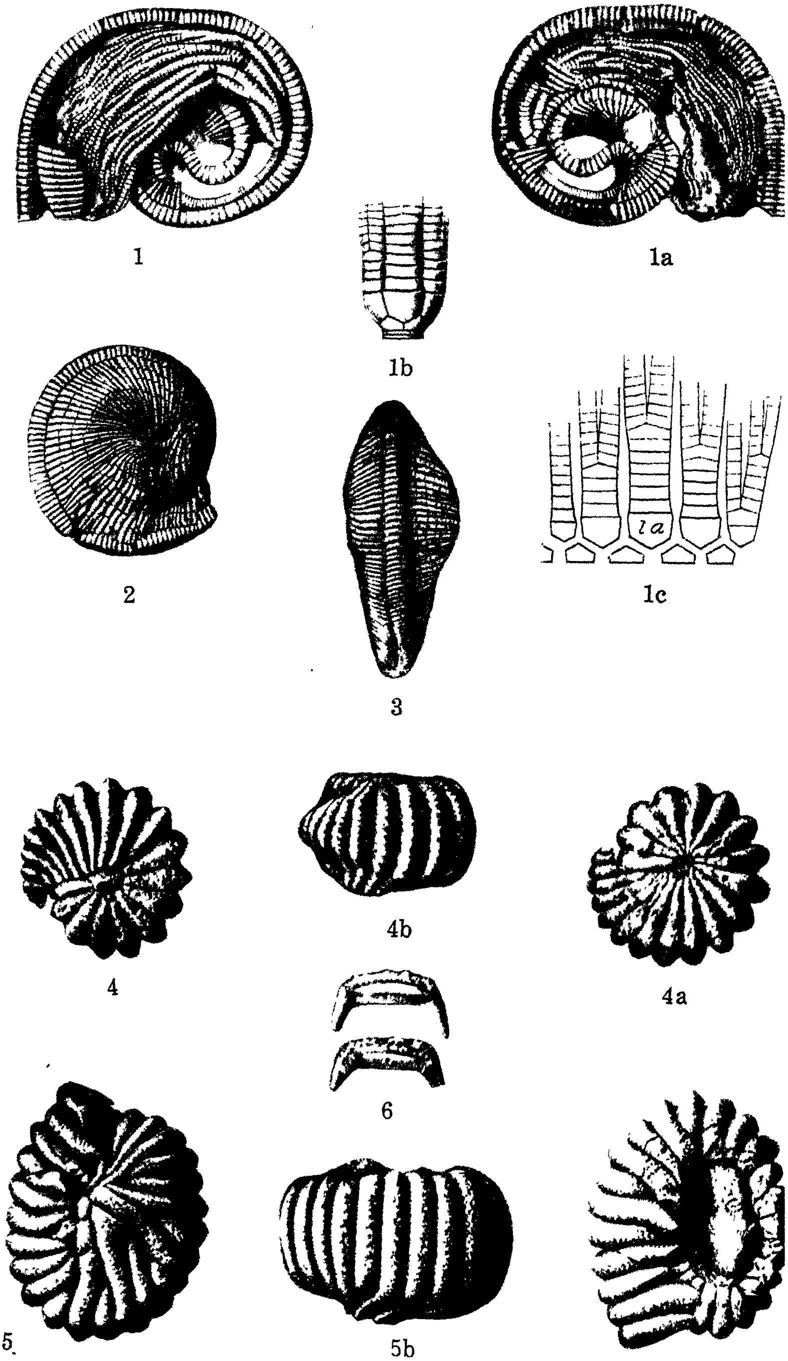
UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 104



UNUSUAL FORMS OF FOSSIL CRINOIDS

## PLATE 6

All figures not otherwise noted natural size

Page

**MYELODACTYLUS KEYSERENSIS**, new species________________ 19

FIG. 1. A nearly complete specimen, lacking only the distal part of the stem; crown fully exposed on both sides by removal of cirri. Seen from the many branched anterior radius, with the unbranched right anterior radius to the left of it. The proximal neck and reverse curve are in full view, and a few cirri are in place distalwards, one to each columnal.

1*a*. Reverse side of same, left posterior view, showing the same structures; cirri exposed opposite some of those seen in the preceding figure, proving their paired arrangement on succeeding columnals. The crescentic stem toward the ends of the arms is 4.5 mm. wide, while the mass of arms is swollen beyond it at either side until it is 12 mm. thick, measured vertical to the plane of these figures.

1*b*. Calyx and lower part of arms of same specimen, from left anterior radius. × 2.

1*c*. Analysis of the crown, showing the presence of five radii, no two alike; r. post. radius at the right with anal tube resting on the left sloping face of the superior half of the radial; r. ant. radius at the left, unbranched; the others branching at different heights. General arrangement similar to that of *Iocrinus*.

2. Another specimen closely inrolled, with crown completely enveloped by the long, slender, cirri converging at the center; swollen to a thickness of 8.5 mm.

3. A specimen showing the great swelling of the crown at the distal region, as it lies enveloped in the cirri; it is here 15 mm. in thickness. Seen from outer curve of stem.

Lower Devonian, Keyser formation; Keyser, West Virginia.

**AMMONICRINUS WANNERI**, new species____________________ 22

FIG. 4. A small specimen, tightly inrolled, seen from the side, showing the large columnals, tapering to a point at the distal end, with strong, apparently non-articulated processes converging toward the center, in the position of cirri. × $\frac{3}{2}$.

4*a*. The same, seen from the reverse side. × $\frac{3}{2}$.

4*b*. The same, seen from outer side of curve, showing the deep beveling of the columnals, their great width and rapid taper to distal end. × $\frac{3}{2}$.

5. The larger specimen; lateral view showing the cirrus-like, but unarticulated, processes converging at the center in irregular forms. Note perforation at the fractured distal end for the axial canal. × $\frac{3}{2}$.

Page

**FIG. 5*a*.** Reverse side of same, with the processes partially removed by preparation, exposing calyx of a Camerate crinoid with trace of arms. × $\frac{3}{2}$. 22

5*b*. Outer curve of same, showing great width of columnals and their rapid diminution distalwards. × $\frac{3}{2}$.

6. Two detached columnals from some other specimen, showing the articulating joint faces, fulcral ridge, perforation for axial canal, and non-articulated processes at the side solidly attached where cirri would be in other forms. × $\frac{3}{2}$.

Middle Devonian; Eifel, Germany.

## PLATE 7

All figures not otherwise noted natural size

| | Page |
|---|---|
| **CAMPTOCRINUS PRAENUNTIUS**, new species | 27 |

FIG. 1. A nearly complete specimen, with scattered cirri at irregular intervals, limited to the distal portion. Natural size.
Mississippian, Burlington limestone; Burlington, Iowa.

| | |
|---|---|
| **CAMPTOCRINUS MYELODACTYLUS** Wachsmuth and Springer | 28 |

FIGS. 2, 3. Two of the types of Wachsmuth and Springer (North Amer. Crin. Cam., pl. 75, figs. 2*a*, *b*,) after additional cleaning; they show the doubled nodal columnals, each bearing a cluster of two, three, or rarely four, rather short tapering cirri diminishing in size inwards; alternating with these is a single internodal, nearly the length of the pair; occasionally the internodal is wanting, or the cirri limited to one. The cirrus clusters form two marginal rows at the inner side of the curve, the outermost cirrus being so much larger than the others of its cluster that the latter often cannot be seen except by very close observation after careful preparation. × $\frac{3}{2}$.

It should be noted in regard to these and all the figures showing the marginal cirri, especially the detailed sketches, that we only see one row, that upon the opposite margin being omitted in the sketches.

3*a*, 3*b*. Detail from the original of figure 3, including 16 cirri counting from the second cirrus next to the broken off distal end. This drawing is made in two parts for convenience in mounting. The elliptic outlines in this and similar figures give the cross sections from measurements at the part of the stem next to them. Distal is to the right. × 3.

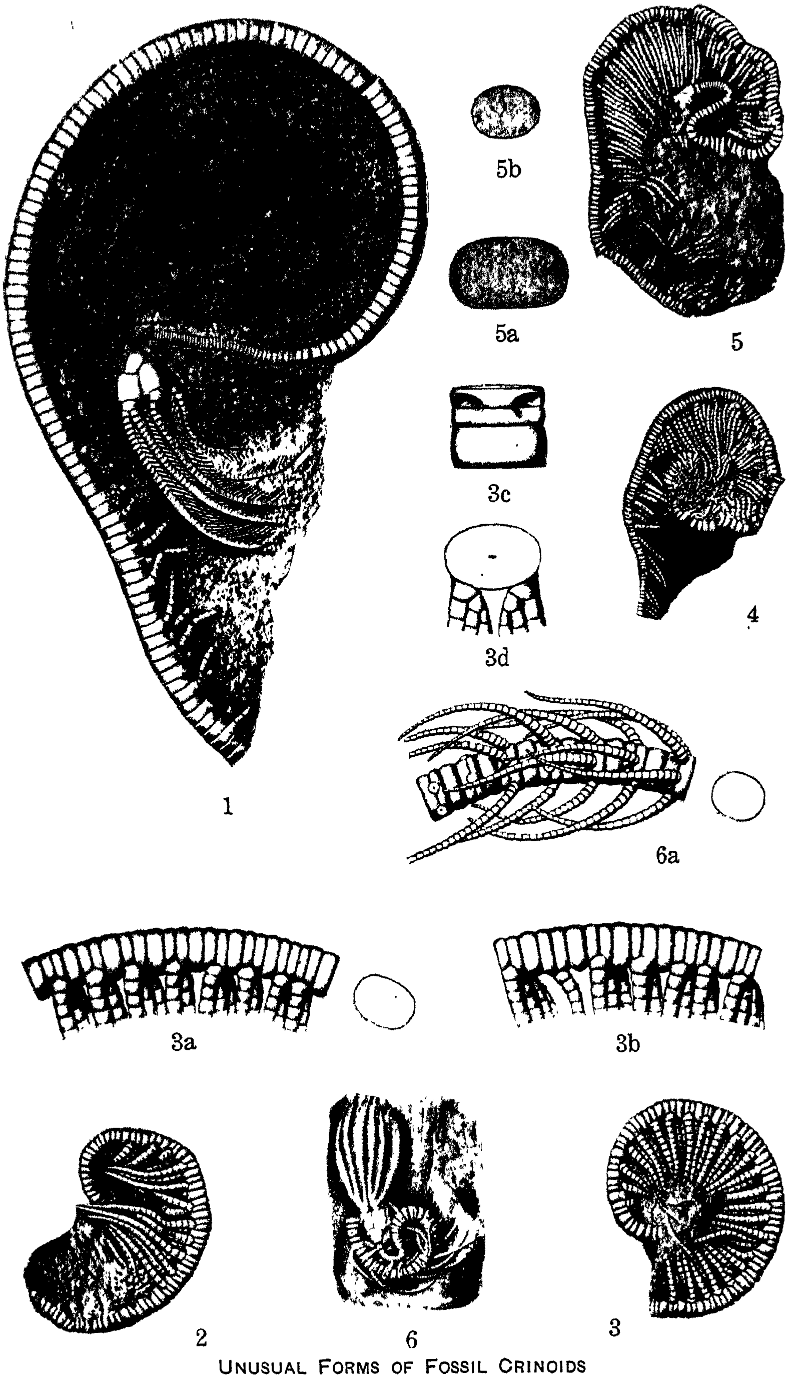
3*c*. Detail from the same specimen, further enlarged, to show the position of the first cirrus-facet directly over the suture between the nodal pair. × 6.

3*d*. Another view showing the mode of succession of the cirri following the first cirrus in the cluster. × 6.

4. A specimen with the stem tapering nearly to the distal end, showing the crowded condition of the cirri as seen unenlarged; in this and the next figure they appear as if chiefly two to the nodal, but the smaller, inner cirri are mostly crowded inward out of sight.

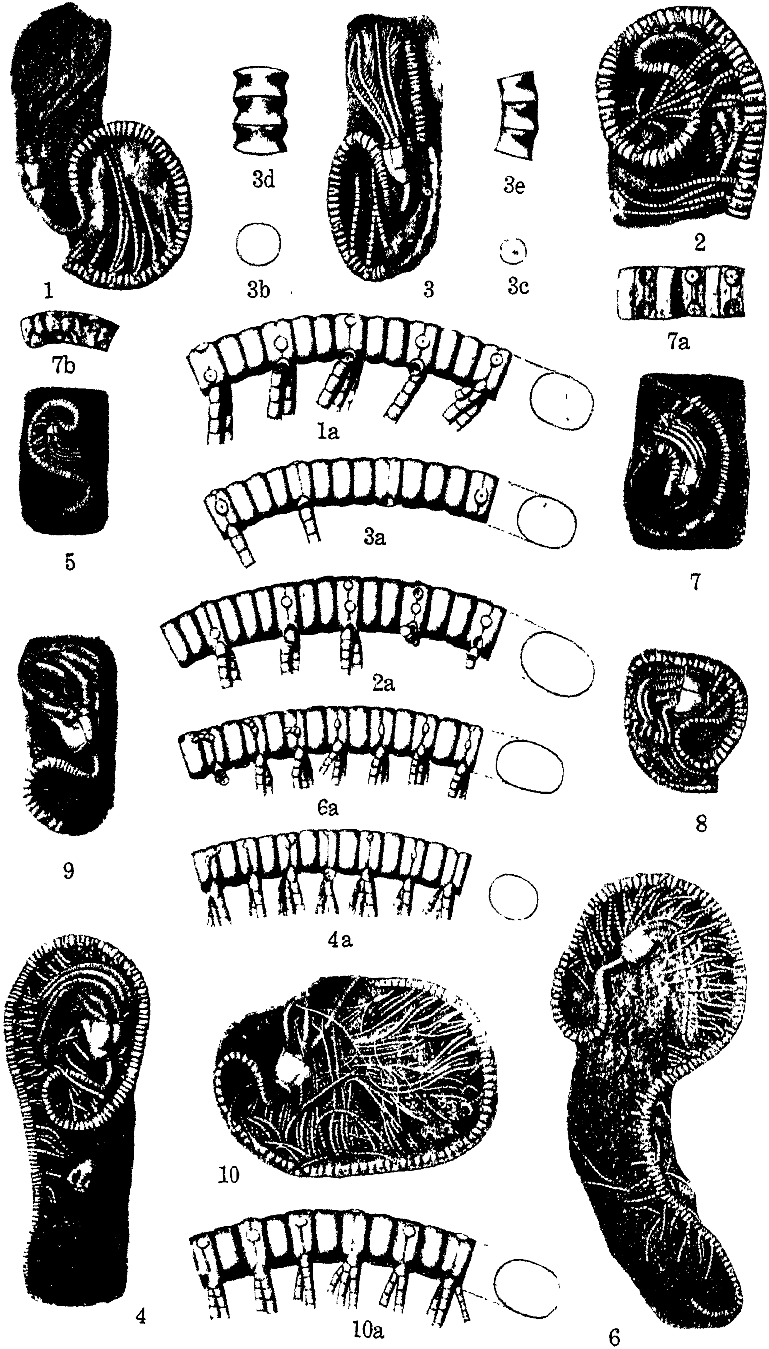
5. The largest specimen, the only one showing the proximal circular part of the stem; it also shows a portion of the calyx, so distorted and cracked that the plates can not be definitely shown. The stem is nearly complete, about 9 cm. long from the proximal part distalwards.

| | Page |
|---|---|
| FIG. 5*a*. Elliptic section of stem, measured at the widest part at right side about opposite the calyx. × 5. | 28 |
| 5*b*. Section measured at about 8 internodes from distal end, where stem becomes nearly circular. × 5. | |
| All Keokuk limestone, Mississippian; Indian Creek, Indiana. | |
| **CAMPTOCRINUS PLENICIRRUS**, new species | 30 |
| FIG. 6. Specimen with crown complete; the stem having the characteristic curves and elliptic section of the preceding species, but the cirri, instead of being limited to two marginal rows of clusters, are distributed as normally in regular whorls of nearly uniform size. | |
| 6*a*. Detail of stem of same specimen, with some cirri restored from the stumps where the dimensions are evident. This should be compared with the figures on plate 8 showing whorls of dwarfed cirri. × 3. | |
| Mississippian, Keokuk limestone; Crawfordsville, Indiana. | |



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGES 107, 108



Unusual Forms of Fossil Crinoids

## PLATE 8

All figures not otherwise noted natural size

| | Page |
|---|---|
| **CAMPTOCRINUS CRAWFORDSVILLENSIS**, new species__________ | 30 |

FIG. 1. Specimen showing full size and proportions of the crown, with probably less than half the stem preserved; clusters of two and three elongate cirri spring from each nodal pair in marginal rows along the inner side of the curve, together with traces of much smaller rudimentary cirri rather irregularly distributed around the periphery of the nodals at the convex outer side; and two, rarely three, internodals interposed.

1*a*. Detail from same next to broken end of stem, with elliptic cross section at right. Distal is toward the left. × 3.

2. A similar specimen, with whorl of dwarfed cirri somewhat better defined; two, or three, internodals.

2*a*. Detail from same next to broken end of stem; with elliptic section at right. Distal toward the right. × 3.

3. Original of Wachsmuth and Springer's plate 75, figure 1, with stem preserved well toward the distal end where it loses its elliptic form; marginal cirri apparently limited to a single one for each nodal pair at either side, and whorls of rudimentary cirri, less prominent than in the last specimen, are also seen; internodals mostly three, also two or four.

3*a*. Detail from same near the fracture at bottom in the figure, with elliptic section measured at the widest part of stem to the left. Distal is toward the left. × 3.

3*b*, 3*c*. Section at the lower fracture, where the stem is nearly round, and at the uppermost fracture where it is entirely so. × 3.

3*d*, 3*e*. Top and side views of part of same stem at the curve to the left of the calyx, where the columnals have become transversely hollowed. × 3.

Mississippian, Keokuk limestone; Crawfordsville, Indiana.

| | |
|---|---|
| **CAMPTOCRINUS MULTICIRRUS**, new species__________________ | 31 |

FIG. 4. Specimen from Huntsville, Alabama, with crown and stem complete; shows the clusters of two and three marginal cirri to the nodal pair, and a very large internodal interposed; basal plates unequal, deformed by pressure of curve. A minute specimen of *Taxocrinus huntsvillae* lies alongside. × 3.

4*a*. Detail from stem of same, with section at right from the median portion; it shows the secondary or incipient cirri disproportionately small, with two or three cirrals developed in some places, and in others only single rudimentary ossicles just broken through on the suture line, without any axial canal to innervate further growth. Distal is toward the left.

Page

FIG. 5. A very young specimen from the same locality, showing form and proportions of complete crown and stem. 31

6. A complete specimen from Monroe county, Illinois, with stem preserved to the extreme distal extremity, showing that it terminated in a point, and had no means of attachment to any solid object except by clinging with the cirri.

6*a*. Detail from same, with elliptic section, showing arrangement of the marginal clusters and the rudimentary cirri, and the undeveloped cirrals lacking the axial canal. Distal is to the right. × 3.

It should be noted that in the two principal specimens, figs. 4 and 6, both sides are well exposed in some places, showing the presence of the two rows of cirrus clusters in conformity with the bilateral, elliptic form of the stem.

7, 8, 9. Three specimens from same locality as last, showing various details of crown and stem.

7*a*, *b*. Inner and side views of columnals from stem of specimen 7, showing position of cirrus-facets with and without remnants of cirri adhering. × 3.

Mississippian, lower part of Chester; Alabama and Illinois.

**CAMPTOCRINUS CIRRIFER** Wachsmuth and Springer___________ 32

FIG. 10. Type of Wachsmuth and Springer (pl. 76, fig. 13*a*). A complete specimen, showing the extremely long and slender cirrus clusters.

10*a*. Detail from same, showing the almost undivided nodals, single large internodals, and first cirrals of small secondary cirri. × 3.

Mississippian, upper part of Chester; Pulaski county, Kentucky.

## PLATE 9

All figures natural size unless otherwise stated

Page

**MACROSTYLOCRINUS RECUMBENS**, new species ................ 35

FIG. 1. Side view of a specimen with arms curved backward over the dorsal cup and around the stem; pinnules directed outward.

2. The tegmen of a large specimen in similar condition, showing general outline, origin of arms, and projecting anal plates between the posterior rays.

3. Lateral view of specimen with the arms partly removed; showing relation of calyx, arms, stem and cirri, the plates of two radii, and the first iBr between them.

4. Posterior view of a similar specimen, showing calyx from the anal side, with the anal series complete up to the tegmen.

Lower Devonian, Oriskany; Cumberland, Maryland.

**PLATYCRINUS PENDENS**, new species ........................ 38

FIG. 5. Dorsal view, showing calyx as enveloped by the closely recumbent arms; much distorted by pressure.

5*a*. Ventral view of same; showing food grooves, and pinnules directed to the exterior.

Mississippian. Kinderhook; Le Grand, Iowa.

**BARRANDEOCRINUS SCEPTRUM** Angelin ........................ 35

FIG. 6. A complete specimen showing the relative position of the recumbent arms and stem, and the depressions caused by the contact of arms with the surface of the calyx. For comparison with preceding species. From a drawing by G. Liljevall made for Wachsmuth and Springer. Riks Museum, Stockholm.

7. A specimen in the author's collection, in which the calyx is completely enveloped by the recumbent arms.

Silurian, Wenlock limestone; Gotland, Sweden.

**ACROCRINUS AMPHORA** Wachsmuth and Springer ............ 40, 44, 45

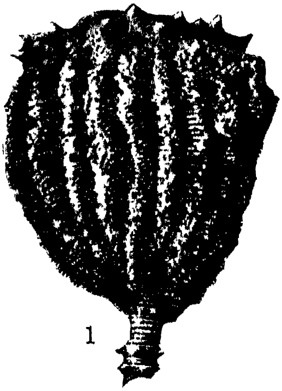
FIGS. 8, 9. Specimens showing the tegmen, composition of the calyx, position of the arm bases, and the marks of pressure by arms upon the outer surface.

Lower Chester, Ohara formation; Huntsville, Alabama.

A coiled stem; not **MYELODACTYLUS** .......................... 15

FIG. 10. A normal stem of unknown species, spirally coiled around a fragment of another stem. For comparison with figures on preceding plates.

Niagaran. Waldron shale; Newsom, Tennessee.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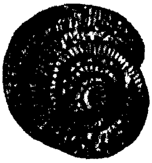
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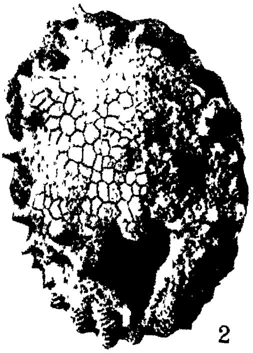
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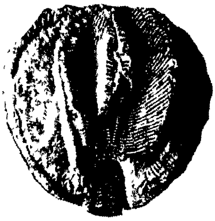
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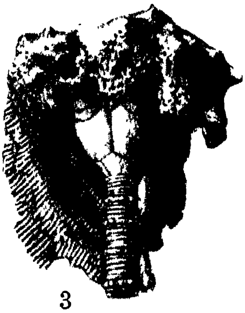
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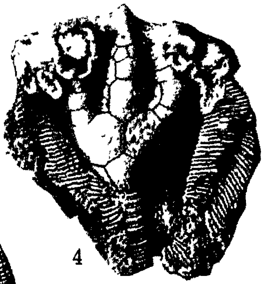
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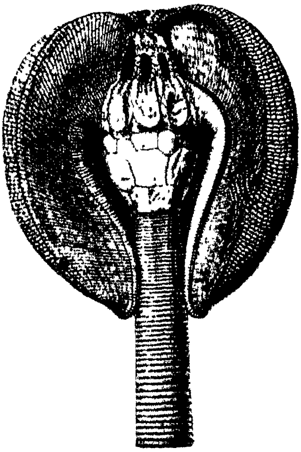
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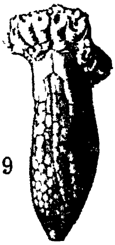
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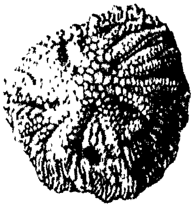
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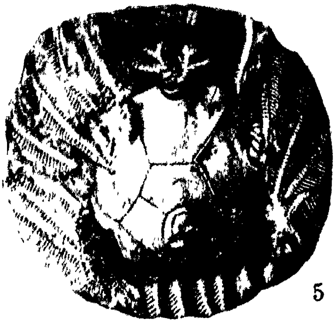
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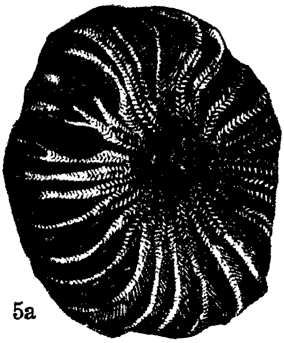
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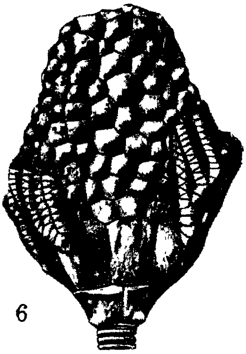
UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 112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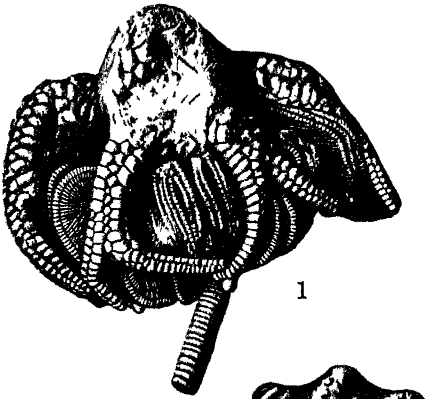
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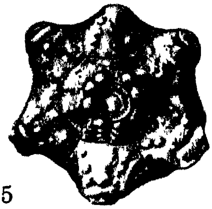
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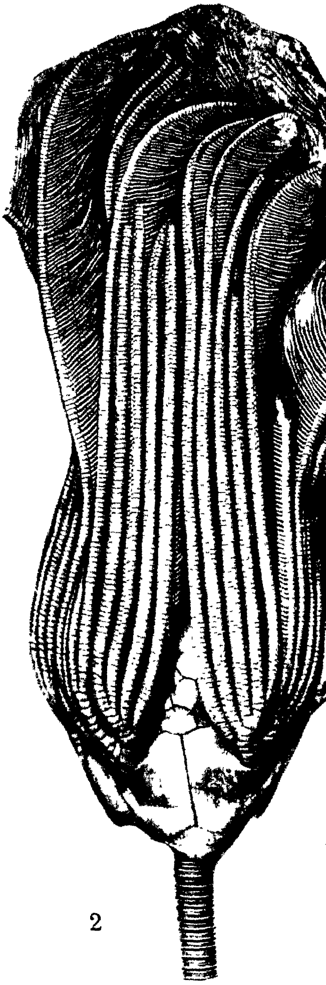
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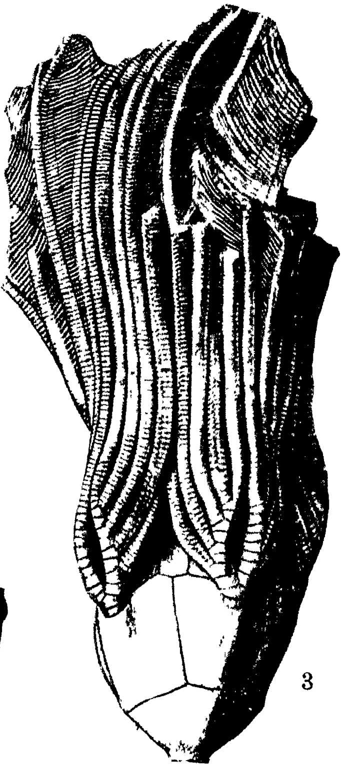
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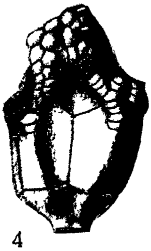
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UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 113

## PLATE 10

All figures natural size

| | Page |
|---|---|
| **GILBERTSOCRINUS DISPANSUS** Wachsmuth and Springer________ | 38 |

FIG. 1. Specimen with the true arms in place; to show the arms partially recumbent, with the position of the arms and pinnules apparently opposite in the same individual. In the middle part the arms bend downward, and the pinnules are outermost, away from the calyx; at either side the arms make a reverse curve, bending upwards, so that the pinnules point inwards toward the calyx. The hump at the top is a *Platyceras*, fastened over the anal opening to feed upon the excrement of the crinoid.

Keokuk limestone; Indian Creek, Indiana.

| | |
|---|---|
| **PARADICHOCRINUS PLANUS**, new species______________________ | 51 |

FIG. 2. An extremely large specimen, with 5 or 4 arms to the cluster in each half ray, formed by successive unilateral branching to the outer side of the dichotom. The very thin and smooth calyx plates are much broken by pressure, and their arrangement has been restored from other specimens. Interradial view.

3. A smaller specimen in which the arrangement of the calyx plates and their perfectly smooth surface are well shown; it has 5 arms to each outer side of the dichotom. Interradial view.

4. A calyx, to show structure of the tegmen.

Keokuk limestone, lower horizon; Indian Creek, Indiana.

| | |
|---|---|
| **PARADICHOCRINUS POLYDACTYLUS** Casseday and Lyon________ | 50 |

FIG. 5. Dorsal view of a vertically flattened calyx, to show the strong, pustular or nodose ornamentation, in contrast to the smooth surface of the last species.

6. Posterior view of a calyx with nodose ornament, and showing the great elevation of the tegmen. For the arm structure of this species see Wachsmuth and Springer (North Amer. Crin. Cam., pl. 77, fig. 1*a*).

Keokuk limestone, higher horizon; Crawfordsville, Indiana.

## PLATE 11

All figures natural size

Page.

**DICHOCRINUS PENDENS** Wachsmuth and Springer 39

FIG. 1. The holotype, figured in North American Crinoidea Camerata, pl. 78, fig. 15, showing the relation of calyx, pendent arms, pinnules, and stem.

2. Another specimen, showing form of calyx, with the arms mostly removed.

3. A specimen with calyx completely enveloped by arms bent backward upon the stem; pinnules at the outside.

4. Specimen with complete stem and branching root; no cirri.

Upper Burlington limestone; Burlington, Iowa.

**DICHOCRINUS OBLONGUS** Wachsmuth and Springer 40

FIG. 5. The holotype, calyx only, figured in North American Crinoidea Camerata, pl. 78, fig. 9.

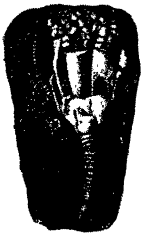
6. A specimen discovered since the original description, showing the pendent arms.

Warsaw limestone; Spergen Hill, Indiana.

**DICHOCRINUS** cf. **ANGUSTUS** White 39

Fig. 7. A specimen with long stem but lacking the arms; having extremely long curri, enveloping the small calyx in an upward direction.

Upper Burlington limestone; Burlington, Iowa.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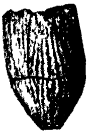
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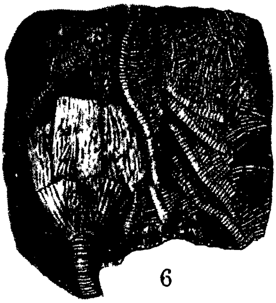
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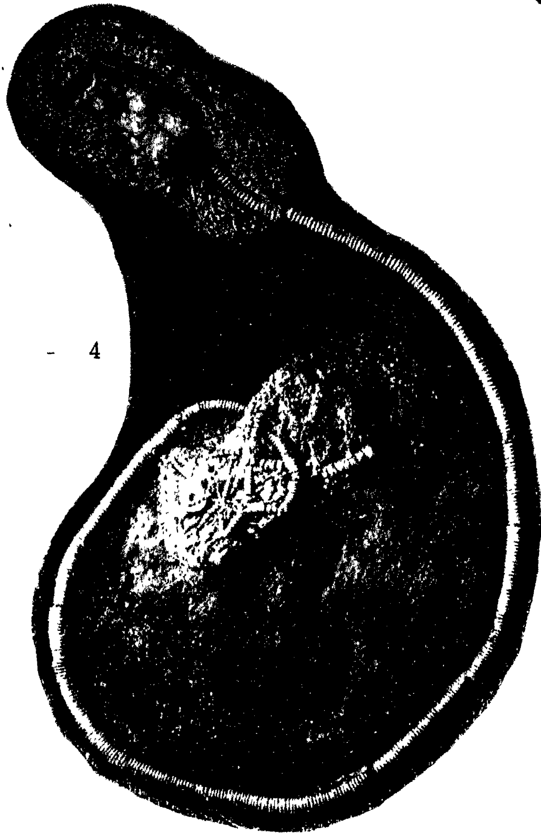
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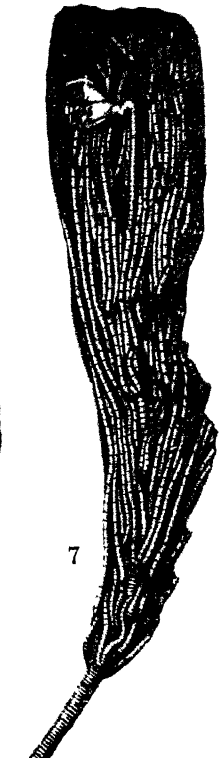
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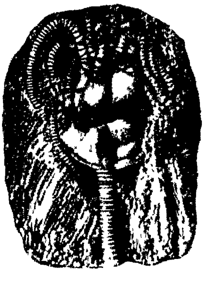
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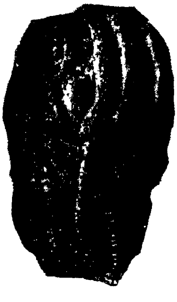
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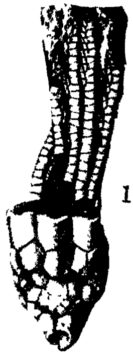
Unusual Forms of Fossil Crinoids



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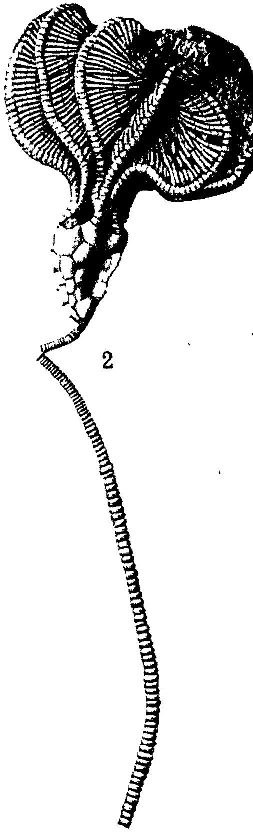

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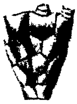

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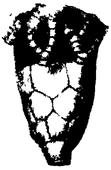

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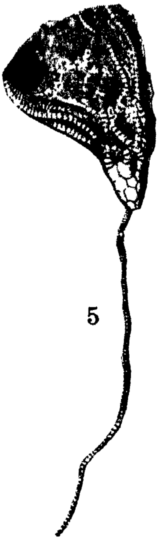

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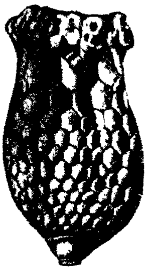

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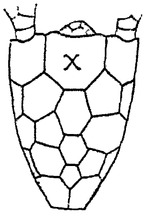

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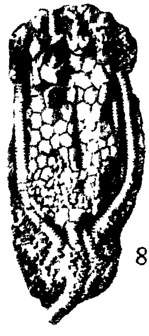

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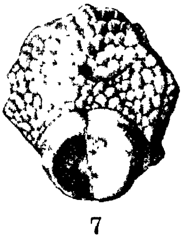

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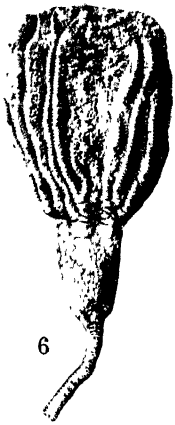

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UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 115

## PLATE 12

All figures natural size unless otherwise stated

Page

**ACROCRINUS PRAECURSOR**, new species ------------------------ 42

FIG. 1. Posterior view of calyx and part of arms, both somewhat displaced by pressure, showing numerous ranges of irregular plates between BB and RR.
Upper Burlington limestone; Burlington, Iowa.

**ACROCRINUS INTERMEDIUS**, new species ------------------------ 43

FIG. 2. A complete crown with long stem; r. post, view, showing erect, biserial arms and pinnules, and the anal series with pyramid of small plates surmounting it. Has 3 ranges of plates between BB and RR. × 2.
2*a*. Diagram of calyx of same; drawn from the posterior side, giving the complete succession of anal plates.
3. Similar view of a detached calyx having 2 and 3 ranges of supplemental plates interposed. × 2.
4. Right anterior view of calyx of another specimen with 2 ranges of plates interposed. × 2.
5. Anterior view of a nearly complete crown and stem, with 2 ranges of plates interposed; natural size.
Lower Chester; Monroe County, Illinois.

**ACROCRINUS SHUMARDI** Yandell -------------------------- 41, 44, 45

FIG. 6. A complete crown, with arms erect. Grayson Springs.
7. Lower part of calyx. After Wachsmuth and Springer. Sloan's Valley, Pulaski County. × 2.
Upper Chester, Glen Dean formation; Kentucky.

**ACROCRINUS AMPHORA** Wachsmuth and Springer ---------- 40, 44, 45

FIG. 8. A specimen from Huntsville, to show relation of base, calyx with supplementary plates, and recumbent arms.
9. A complete calyx without the arms, to show the arrangement of plates. Same locality. After Wachsmuth and Springer. × $\frac{3}{2}$.
Lower Chester, Ohara formation; Huntsville, Alabama.

**ACROCRINUS WORTHENI** Wachsmuth ------------------------ 45

FIG. 10. Outline of the calyx, to show relative size After Wachsmuth and Springer.
Lower Coal Measures; Peoria County, Illinois.

## PLATE 13.

All figures natural size unless otherwise noted

Page

**TALAROCRINUS PATEI** Miller and Gurley____________________ 46

FIGS. 1, 2, 3, 4. A series of complete crowns, part of a colony of several hundred specimens from one locality; showing variation in number of arms from 4, 3, and rarely 2 to the ray. Fig. 3 shows a normal anal plate, completely separating the adjacent radials.

5. A specimen with abnormal anal plate, wedge shaped, with the two radials meeting above it—a variation toward *Pterotocrinus.*

6–12. A series of calices from the same colony showing different forms of tegmen, in which the axillary ambulacral is but slightly developed, or not at all. Fig. 12 is enlarged × 2.

13. Lateral view of a calyx in which the axillary ambulacrals are developed into strong nodes, two of which have been displaced, affording a view of the facets in which they were seated. 13*a* is the nodose ambulacral which came out of the facet seen directly at the front. × 2.

14. Basal view of calyx.

Lower Chester, Ohara formation, formerly called St. Louis, and afterwards Ste. Genevieve; near Sample, Breckinridge County, Kentucky.

**TALAROCRINUS SEX-LOBTUS** Shumard______________________ 46

FIG. 15. Specimen with very strong spines, closely resembling the form of these plates in some species of *Pterotocrinus.* × 2.

Upper Chester, Gasper formation; Flagpoint, Virginia.

**PTEROTOCRINUS ACUTUS** Wetherby_________________________ 50

FIG. 16. The axillary ambulacrals hypertrophied into large, club-shaped appendages, tapering to a point. The remainder of the tegmen is covered by a *Platyceras* permanently attached over the anus for feeding commensally upon the excrement of the crinoid.

Upper Chester, Glen Dean formation; Sloan's Valley, Pulaski County, Kentucky.

**PTEROTOCRINUS RUGOSUS** Lyon and Casseday_________________ 47

FIGS. 17, 18, 19, 20. Lyon's type (17) with thin wing-like processes; and other specimens showing basal, lateral, and tegminal views—the latter especially showing the facets in which the processes are seated.

Upper Chester, Gasper formation; Breckinridge County, Kentucky.

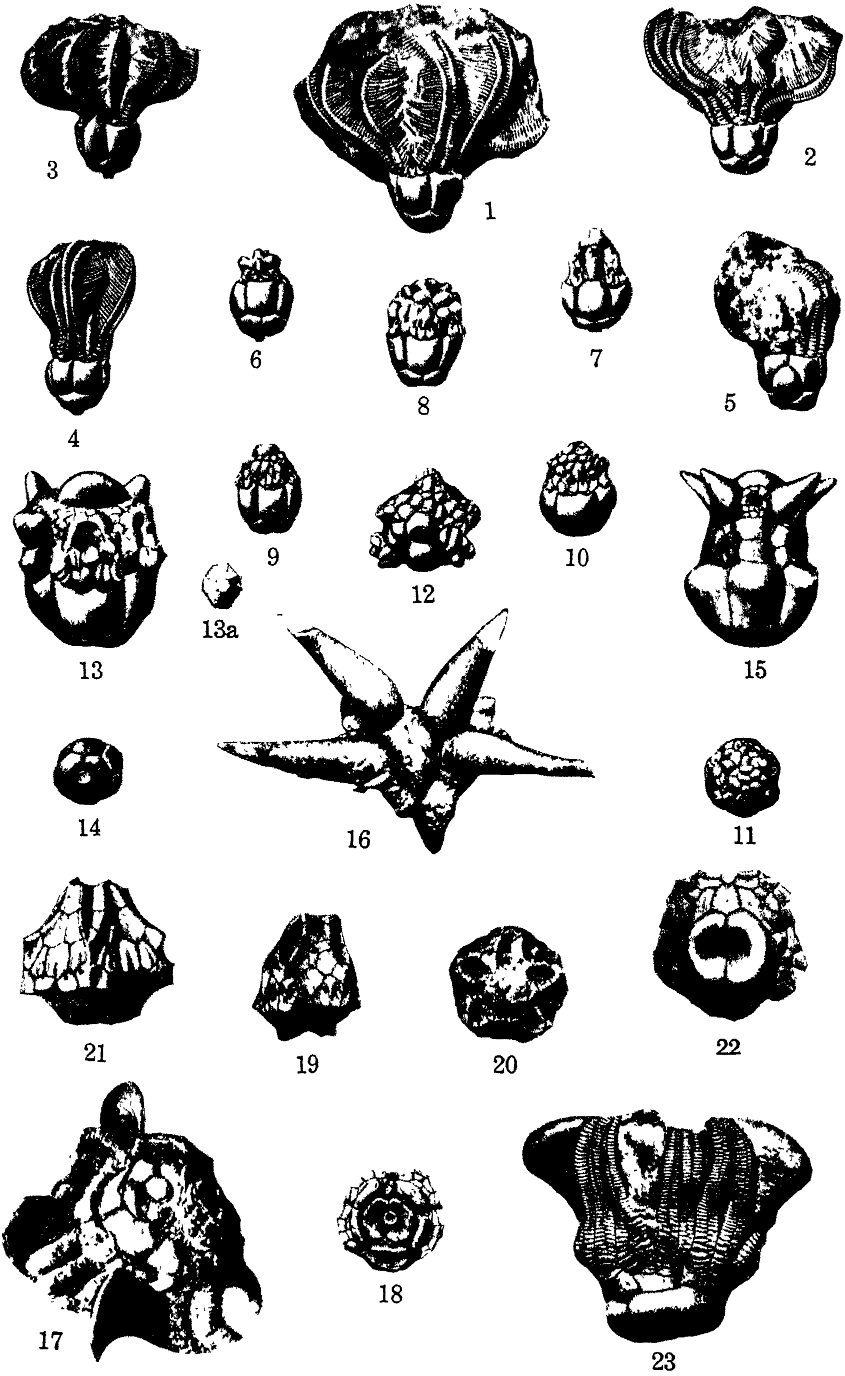
Page

**PTEROTOCRINUS PYRAMIDALIS** Lyon and Casseday............ 50

FIGS. 21, 22. Lateral and basal views of the type.
Horizon and locality same as last.

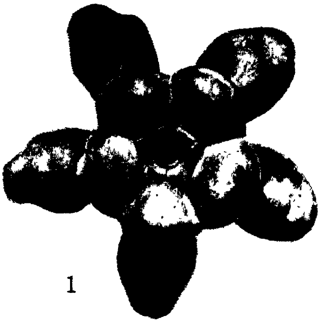
**PTEROTOCRINUS CAPITALIS** Lyon and Casseday............... 49

FIG. 23. The type, with extremely large and gibbous basals, and heavy processes, thickening outward to large blunt extremities.
Upper Chester, Golconda formation; Crittenden County, Kentucky.



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGES 117, 118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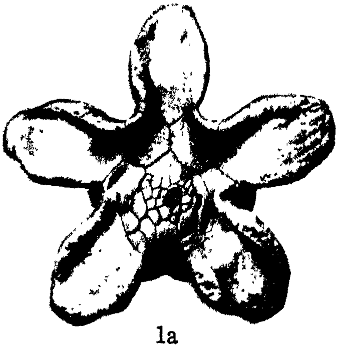
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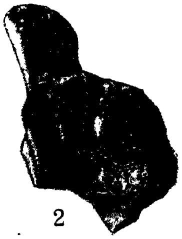
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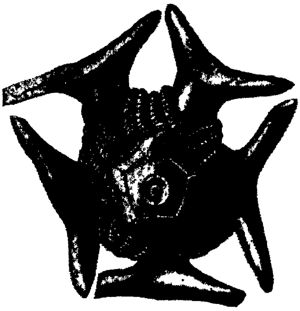
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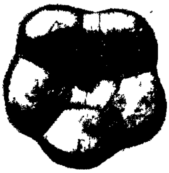
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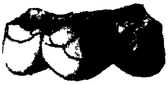
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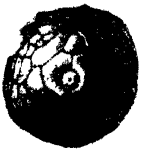
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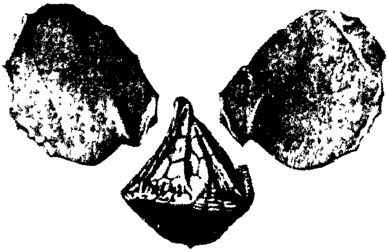
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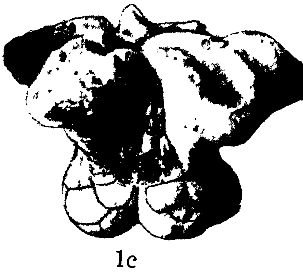
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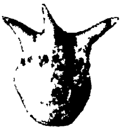
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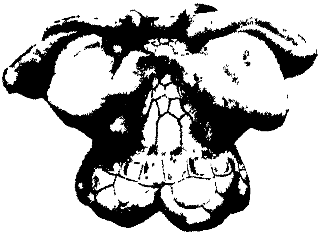
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UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 119

## PLATE 14

All figures natural size

Page.

**PTEROTOCRINUS CORONARIUS** Lyon ........................... 48

FIGS. 1, 1*a*, 1*b*, 1*c*. The holotype, with the dorsal cup added to the tegminal part originally figured by Lyon, and afterwards by Wachsmuth and Springer; dorsal, ventral, antero- and postero-lateral views; showing the great size of the gibbous radial plates, contrasted with those of all other known species and the huge, massive spatulate processes into which the axillary ambulacrals have developed.

2. A fractured specimen found associated with the preceding, having one of the spatulate "wing processes" attached to the dorsal cup, both of the same type as those of figure 1, proving beyond question that the two belong toegther.

3, 3*a*. Basal and lateral views of another specimen from the same locality, with only the dorsal cup preserved.

Upper Chester, Golconda formation; Crittenden County, Kentucky.

**PTEROTOCRINUS DEPRESSUS** Lyon and Casseday ............... 50

FIGS. 4, 4*a*. The species with the "wing processes" laterally compressed into thin, knife-like "blades," in contrast to the ponderous appendages of most of the other species. Lateral view of calyx, with two detached "blades" in proper position; and a dorsal view for comparison of form and proportions of basal and radial plates with those of fig. 1.

Upper Chester, Glen Dean formation; Sloan's Valley, Pulaski County, Kentucky.

**PTEROTOCRINUS BIFURCATUS** Wetherby ........................ 50

FIG. 5. In this species the processes of the heavy rounded type have developed in a still different manner by forking almost at right angles. After Wetherby. The original is in the collection of the University of Chicago.

Upper Chester, Glen Dean formation; Sloan's Valley, Pulaski County, Kentucky.

**TALAROCRINUS CORNIGERUS** (Shumard) ........................ 46

FIG. 6. A specimen with the axillary ambulacral developed into prominent spines—precursor of the winged processes of *Pterotocrinus*.

Lower Chester, Ohara formation; Tateville, Pulaski County, Kentucky.

## PLATE 15

All figures natural size unless otherwise noted

| | Page |
|---|---|
| **AGASSIZOCRINUS CONICUS** Owen and Shumard | 53, 59, 63 |

FIG. 1. The holotype, from Chester, Illinois. Note the great length of the fused infrabasal cone, over half the total height of the calyx. The sharply conical contour is not an inflexible character for the species, as there is upon the same matrix with the type another specimen with a more rounded ovoid outline; but the high IBB cone seems to hold good. Coll. U. S. National Museum, No. 17937.

2. A very large specimen also from Chester, more broadly rounded than the type, with IBB half the height of calyx.

3, 4. Two very elongate fused IBB cones, perhaps of this species, but much smaller than that of the type; part of a series of 10 or more similar elongate bases found at the same locality in Union County, Illinois, varying in contour from conical to ovoid, but agreeing in the extremely high IBB. Fig. 4 is from a specimen longitudinally bisected, showing the axial canal extending almost to the end of the fused cone.

Upper part of Chester, Okaw formation.

**AGASSIZOCRINUS LAEVIS** (Roemer) 53, 55, 63

FIG. 5. The holotype, original of Roemer's figure, formerly in the collection of B. F. Shumard. A direct photograph, showing the arms as they actually are in the specimen (partly restored in the type figure), and the anal plates (not shown in the original figure). The r. post. ray is well shown nearly to the end of the arms. IBB, though solidly fused at the bottom, have sutures for a short distance from the upper margin. Chester, Illinois.

5*a*. L. ant. view of same, showing the great width of the radial, the axillary IBr with its unequal faces, and the increased size of the left arm as compared with those of the adjoining r. post. ray.

6, 7. Anterior and posterior views of two calices from Clear Creek, Hardin County, Kentucky.

Upper Chester, Okaw, and Glen Dean formations.

**AGASSIZOCRINUS GIBBOSUS** Hall 53, 63

FIGS. 8, 9. Posterior and anterior views of two characteristic specimens, that of fig. 8 being perfectly typical.

Upper Chester, Okaw formation; Chester, Illinois.

**AGASSIZOCRINUS INEQUIDACTYLUS** (Whitfield) 57, 62, 63

FIGS. 10, 10*a*. Posterior and anterior views of specimen from Sloan's Valley, Pulaski County, Kentucky, with arms broken off slightly above the primibrachs; showing the unequal radials, small size of anterior arm, and unequal faces of the anterolateral primibrach.

11, 11*a*. Similar views of another specimen from the same locality, having part of the hypertrophied left lateral arm preserved, showing its great size as compared with those adjacent.

Page

FIGS. 10*b*, 11*b*. Cross sectional views of the fractured arms of the two preceding specimens, in which the inequality of the arms in both is still more apparent. 63

12. A calyx from Stephensport, Breckenridge County, Kentucky, in the upper series of the Chester, showing the unequal faces of a lateral primibrach.

13. The original of Lyon's proposed description. A nearly complete crown, with the two pairs of posterior arms and the enormously hypertrophied antero-lateral arms in full view; giving a complete exposition of the dominant character of the genus. Grayson Springs, Grayson County, Kentucky. × $\frac{3}{2}$.

Upper Chester, Glen Dean formation.

**AGASSIZOCRINUS GLOBOSUS** Worthen ------------------------- 54, 63

FIG. 14. Posterior view of calyx, slightly less broadly rounded than the type; one of a number of specimens of this and the following species varying slightly in contour from strictly globose to subovate. Near Hardinsburg, Breckenridge County, Kentucky.

Upper Chester, Gasper formation.

**AGASSIZOCRINUS OVALIS** Miller and Gurley ------------------- 54, 63

FIGS. 15, 16, 17. Posterior, anterior, and distal views of three calices from same locality as the last; that of fig. 17 to show by direct view the relative width of the radials. There is practically no difference between the specimens referred to this and the preceding species except the divided and fused infrabasal cone, and as to this there are apparently intermediate stages, as well as variation in contour from ovoid to globose.

Horizon and locality same as last.

**AGASSIZOCRINUS**, species ------------------------------------ 57

FIGS. 18, 19, 20. Dorsal views and a lateral view of three bases, from same locality as last, in different stages of division of infrabasals; the sutures being more or less obscure, in some deviating from a straight line, and in some passing only part way down. A number of other specimens exhibit similar unstable features; and the condition of the Breckenridge County forms as here shown leads to the inference that in this formation at least the IBB may be divided or fused in the adult stage within the same species.

Upper Chester, Gasper formation; Breckenridge County, Kentucky.

**AGASSIZOCRINUS**, species ------------------------------------ 56

FIGS. 21, 22, 23. Three infrabasal cones from Huntsville, Alabama, perhaps of the same species, of minimum, medium, and maximum size; the first two being solidly fused, and the last, fig. 23, being divided by distinct sutures at the distal face which extend almost to the lower end.

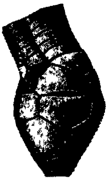
Upper Chester, Gasper formation.

**AGASSIZOCRINUS**. species ------------------------------------ 57

FIG. 24. Distal face of a fused cone in which the axial nerve canals, being restricted in their downward course, are split into radiating branches passing outward into the wall of the cup.

25. Similar cone in which the nerve canals penetrate the fused infrabasals undivided for part of their length.

Upper Chester, Gasper formation; Huntsville.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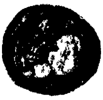
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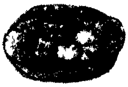
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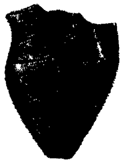
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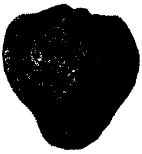
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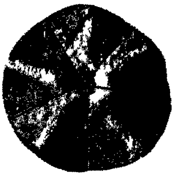
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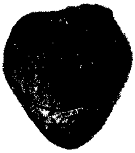
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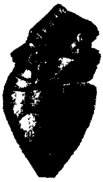
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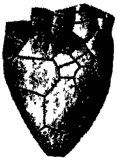
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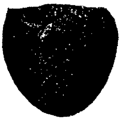
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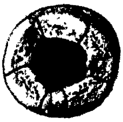
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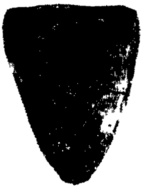
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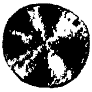
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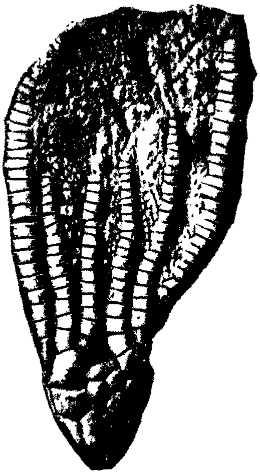
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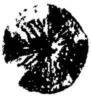
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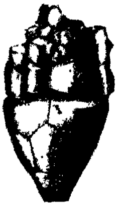
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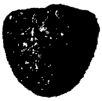
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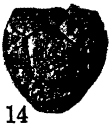
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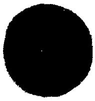
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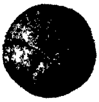
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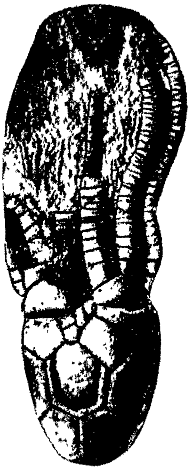
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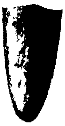
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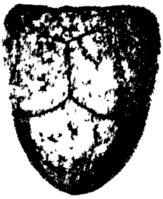
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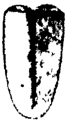
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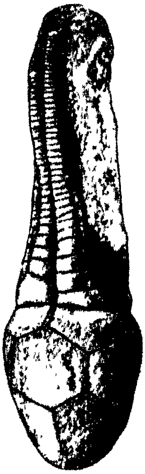
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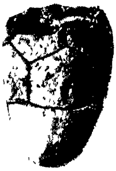
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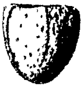
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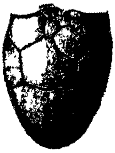
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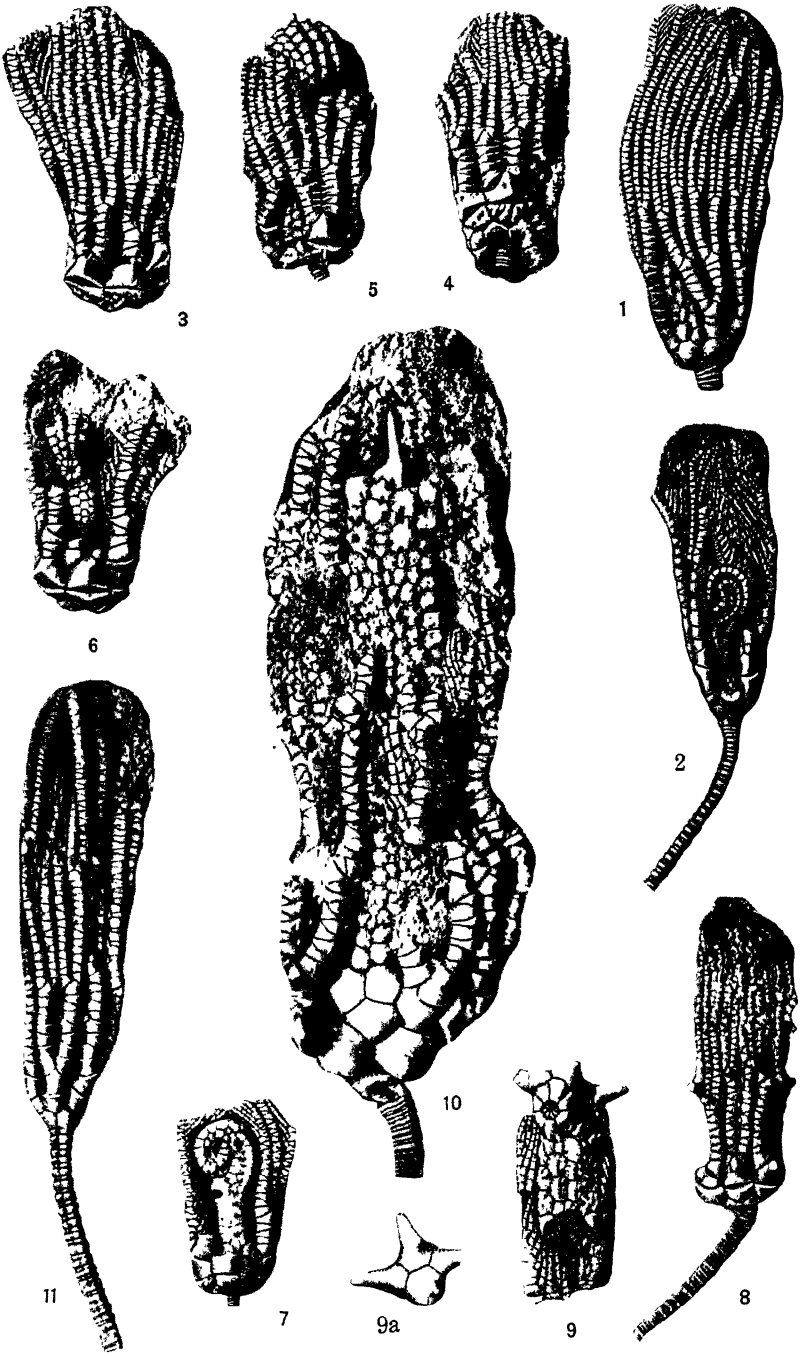
UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGES 121, 122



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 123

## PLATE 16

Natural size unless otherwise stated

Page

**PACHYLOCRINUS AEOUALIS** (Hall) ---------------------------- 71

FIG. 1. Posterior view, to show anal side passing into ventral sac, and mode of arm branching.
Keokuk limestone; Crawfordsville, Indiana.

**PACHYLOCRINUS SCOPARIUS** (Hall) ---------------------------- 67

2. Lateral view, l. ant., showing the sac curving upon itself toward the anterior.
Upper Chester; Grayson Springs, Kentucky.

**PACHYLOCRINUS ARBOREUS** (Worthen) -------------------- 65, 67, 71

3. Anterior view, showing structure of arms and pinnules. × $\frac{3}{2}$.
4. Another specimen, l. post. view, giving also a basal view of the calyx. × $\frac{3}{2}$.
5. R. post. radial view of another specimen, showing anal side and curvature of inflated sac. × $\frac{3}{2}$
6. R. ant. radial view, showing nearly full length of sac, doubling on itself toward the anterior, with opening about midway. × $\frac{3}{2}$.
7. L. post. view of similar specimen, showing full length of sac, with curvature in side view, and anal opening at the left. × $\frac{3}{2}$.
Lower Chester; Huntsville, Alabama.

**PACHYLOCRINUS FLOREALIS** (Yandell and Shumard) ------------ 65, 72

FIG. 8. A complete crown, showing the distal end of the sac projecting beyond the arms.
9. Distal portion of sac from another specimen with spiniferous projection, and the anal opening next to it. × $\frac{3}{2}$.
9*a*. The spiny projection of same seen from the upper side, consisting of four plates. × $\frac{3}{2}$.
Upper Chester; Grayson Springs, Kentucky.

**PACHYLOCRINUS AQUALIS** (Hall) ---------------------------- 71

10. Posterior view of large specimen showing full length of sac with terminal spine, and arms extending beyond it.
Lower Burlington limestone; Burlington, Iowa.

**ABROTOCRINUS RUSTICELLUS** (White) ------------------------ 72

11. Complete crown with pentagonal stem attached; l. ant. view; the opposite side shows the sac much fractured, not extending beyond the arms, and with opening about midway.
Upper Burlington limestone; Burlington, Iowa.

## PLATE 17

All figures natural size

Page

**ABROTOCRINUS UNICUS** (Hall) ---------------------------------- 65, 73

FIG. 1. Anterior view of complete crown, to show general arrangement of arms, and pentagonal stem.

2. Posterior view of calyx, with sac completely exposed.
3. Anterior view of crown with sac exposed, showing anal opening midway, and spines at distal end.

Keokuk limestone; Crawfordsville, Indiana.

**DECADOCRINUS HALLI** (Hall) ---------------------------------- 65, 91

FIG. 4. Anterior view of complete crown, showing delicate structure of species in the earlier formations.

5. Posterior view of a similar specimen.

Upper Burlington limestone; Burlington, Iowa.

**DECADOCRINUS TUMIDULUS** (Miller and Gurley) -------------- 65, 92

FIG. 6. Posterior view of crown, with tumid basal and anal plates, and inflated distal end of sac. For anal opening in sac, see North American Crinoidea Camerata, pl. 7, figs. 4, 5.

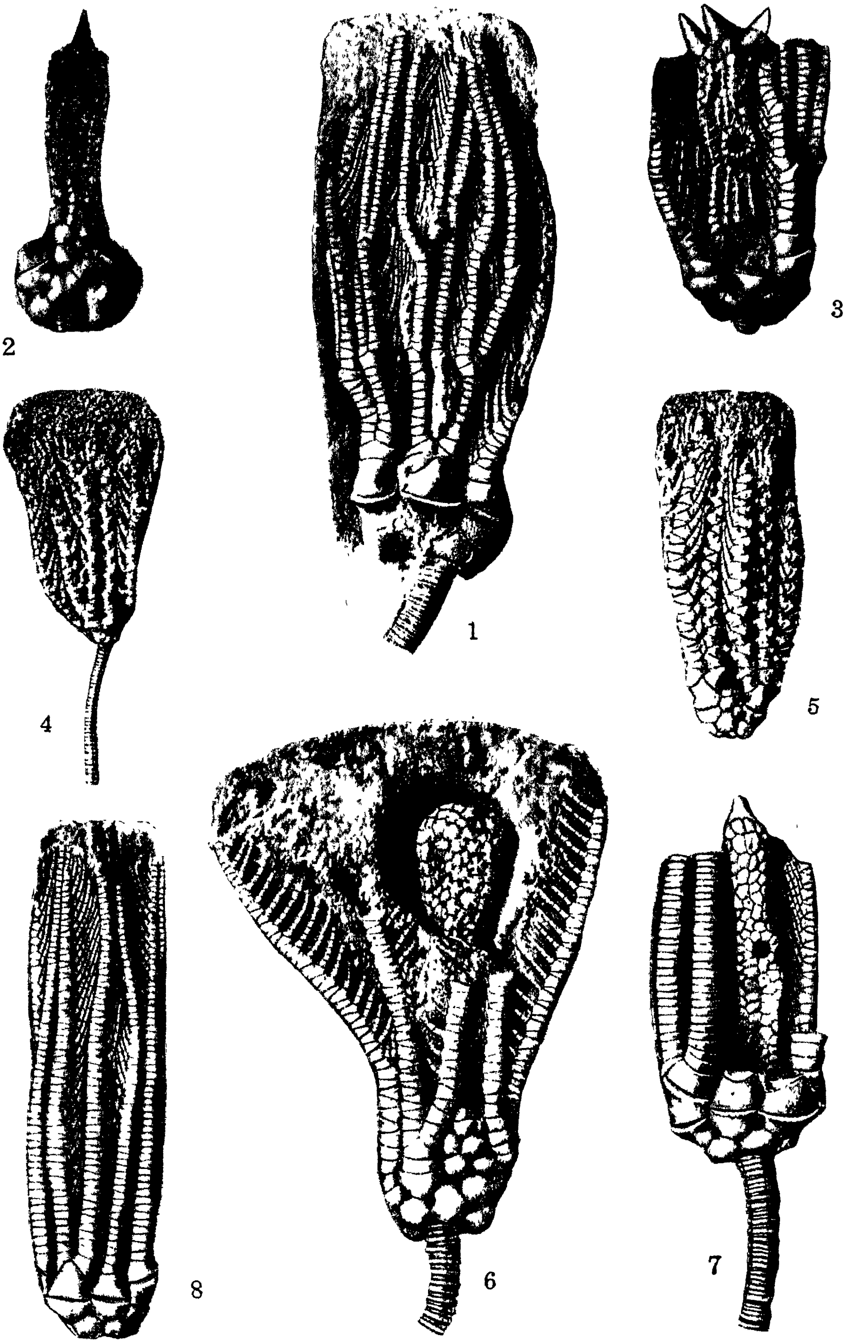
Keokuk limestone; Indian Creek, Indiana.

**SCYTALOCRINUS VALIDUS** Wachsmuth and Springer ------------ 65, 92

FIG. 7. Anterior view of specimen with sac completely exposed, and anal opening midway; arms broken off about half way up.

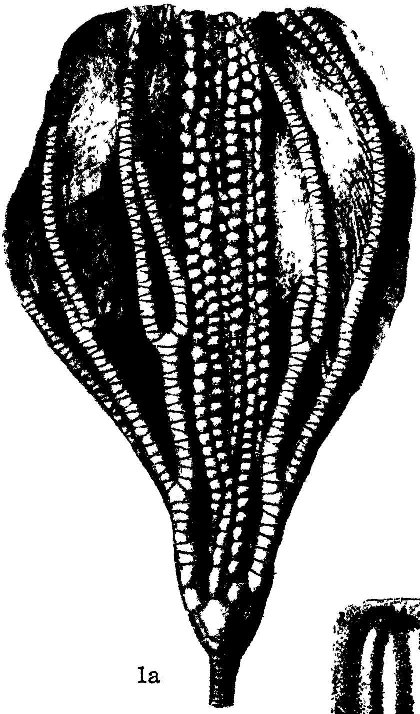
8. Another specimen showing full length of arms, and single arm in anterior ray.

Keokuk limestone; Indian Creek, Indiana.



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 124



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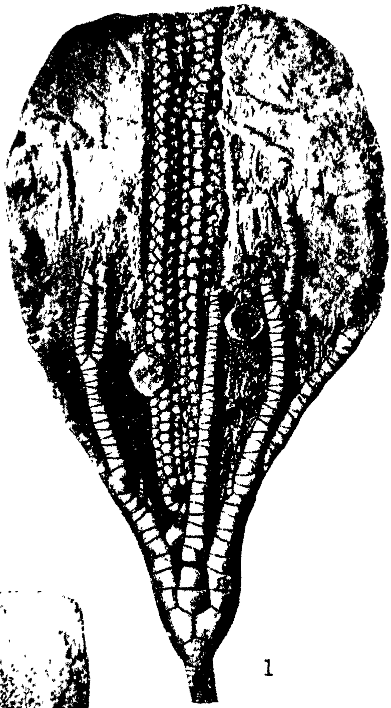

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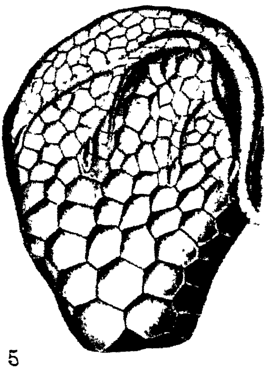

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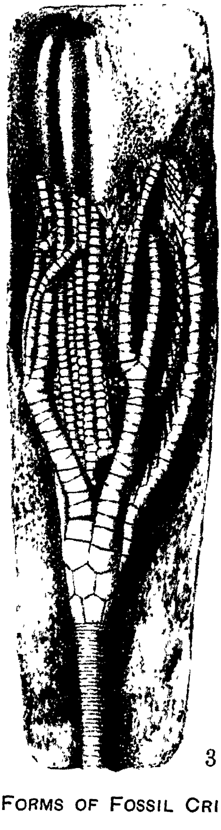

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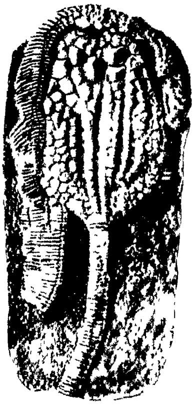

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Unusual Forms of Fossil Crinoids

For explanation of plate see page 125

## PLATE 18

All figures natural size

| | Page |
|---|---|
| **CULMICRINUS ELEGANS** (Wachsmuth and Springer) | 74 |

FIG. 1. Anterior view of crown, with ventral sac to nearly its full length, and anal opening at the base; arms with about 10 IBr.

1*a*. Posterior view of same; showing arms probably extending beyond the sac.

Upper Chester; Sloan's Valley, Kentucky.

FIG. 2. (Omitted.)

| | |
|---|---|
| **CULMICRINUS MISSOURIENSIS** (Shumard) | 74 |

FIG. 3. Anterior view of crown, showing full length of sac, with anal opening at base.

St. Louis limestone; St. Louis, Missouri.

| | |
|---|---|
| **ACROCRINUS AMPHORA** Wachsmuth and Springer | 40 |

FIG. 4. Lateral view of crown, with calyx exposed by removal of part of recumbent arms; to show longitudinal grooves made by pressure of arms in their recumbent position. (See also plates 9 and 12.)

Lower Chester; Huntsville, Alabama.

| | |
|---|---|
| **SIPHONOCRINUS ARMOSUS** (McChesney) | 66 |

FIG. 5. Internal cast, with plates of test exfoliated or removed by chemical action; showing the anal tube bent completely over the oral portions of the viscera, so as to emerge at the anterior side below the level of the arm bases. After Wachsmuth and Springer, North Amer. Crin. Cam., pl. 19.

Niagaran, Racine formation; Milwaukee, Wisconsin.

## PLATE 19.

All figures natural size

Pag

**AULOCRINUS AGASSIZI** Wachsmuth and Springer............... 6

FIG. 1. Anterior view of specimen with sac complete, doubled upon itself and projecting downward in form of a spout, at the end of which is the anal opening; the place of bending marked by spinous nodes.

2. Lateral view of another specimen with sac complete, showing its full curvature leading to the spout. Note the longitudinal ridges, which can be traced the full length of the sac upward and following the curve down again into the spout, the number of ridges being correspondingly increased in the doubled part.

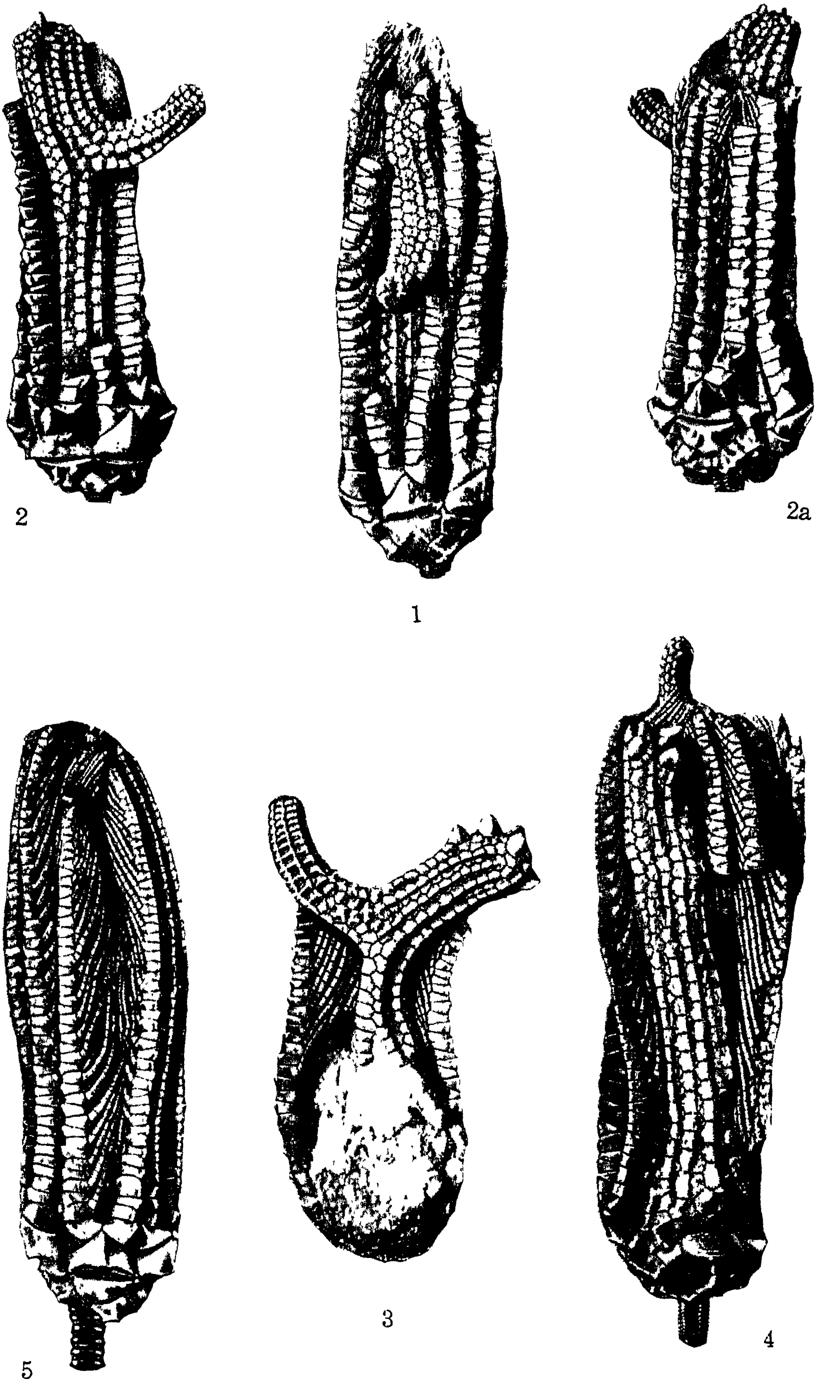
*2a.* Posterior view of same specimen, showing the anal plates, and the sharp angular sculpture of the calyx.

3. Distal portion of another specimen, showing in greater detail the same structures as the last.

4. Posterior view of another specimen, showing the sac complete to the point of bending, marked by spinous nodes, and the distal end of the spout which projects from the opposite side; the sharp sculpture of the anal and other calyx plates; and the pores with which the hexagonal tube plates are profusely perforated at the middle of their sides.

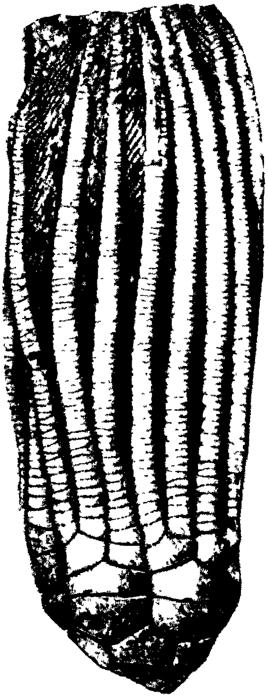
5. Anterior view of specimen with arms in place to their full length, showing their proportions and the character of the pinnules.

Keokuk limestone; Indian Creek, Indiana.



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 126



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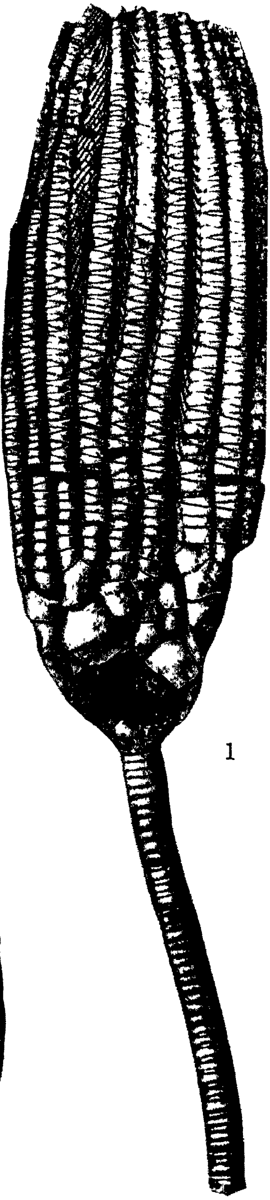

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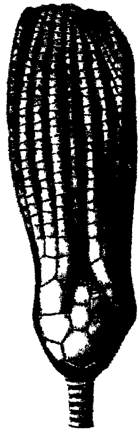

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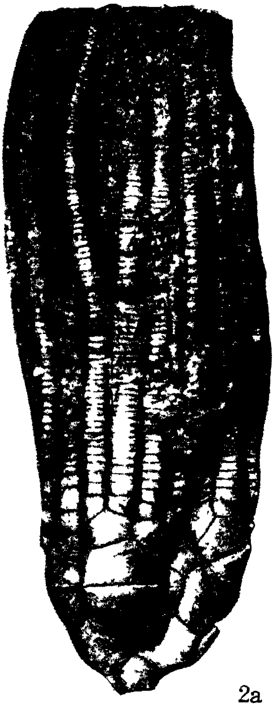

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UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 127

## PLATE 20

All figures except 3 natural size

Page

**ULRICHICRINUS OKLAHOMA**, new species ---------- 76

FIG. 1. Posterior view of principal type, showing distribution of arms and pinnules, form of brachials, structure of stem, and relative size of anal area.

2. Anterior view of another complete crown, showing structure of arms and pinnules, and form and proportions of calyx plates.

2a. Posterior side of same, showing more clearly the structure of the anal area, and the narrowly truncated posterior basal.

Pennsylvanian, Morrow formation; Crittendon, Oklahoma.

**ULRICHICRINUS CORYPHAEUS** (S. A. Miller) ---------- 76

FIG. 3. Posterior view of crown, for comparison with preceding species. × $\frac{3}{2}$.

Mississippian, Keokuk limestone; Indian creek, Indiana.

## PLATE 21

All figures natural size

| | Page |
|---|---|
| **ZEACRINUS BURSAEFORMIS** White | 79 |

FIG. 1. Posterior view of complete crown, showing anal area with broadly truncate post. B, short RA, short quadrangular brachials and heterotomous arms, but having elongate instead of depressed calyx, and turbinate base instead of concave.
Lower Burlington limestone; Burlington, Iowa.

| | |
|---|---|
| **ZEACRINUS ELEGANS** Hall | 65, 80 |

FIG. 2. Anterior view of a typical specimen, with complete crown, showing depressed broadly rounded calyx, and maximum number of bifurcations all on the outer arm of the ray toward the inner side; anterior ray branches on second brachial above primibrach.

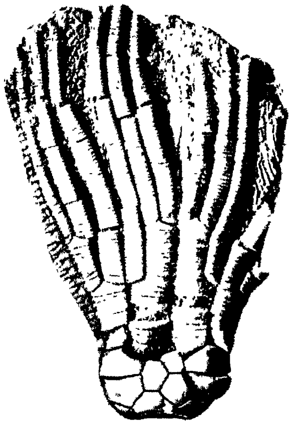
*2a*. R. post. view of same, showing form of club-shaped sac with rounded and expanding distal end.

3. Posterior view of another large specimen having only six arms to the ray.

*3a*. Anterior view of same, with anterior ray bifurcating on third brachial, and having only 4 arms.

4. Posterior view of small specimen, with typical form of anal area for the earlier species—broadly truncate post. B. and short RA.

Upper Burlington limestone: Burlington, Iowa.



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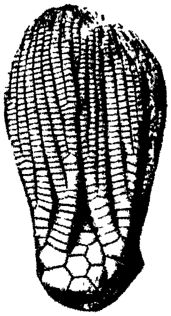

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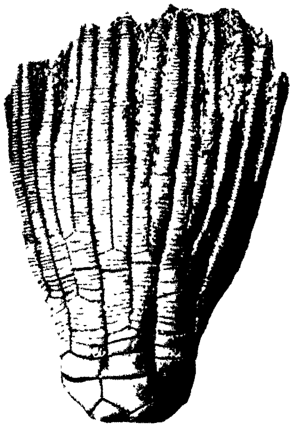

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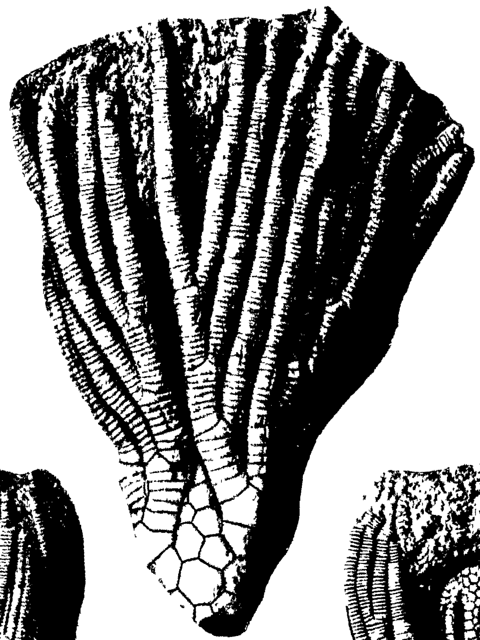

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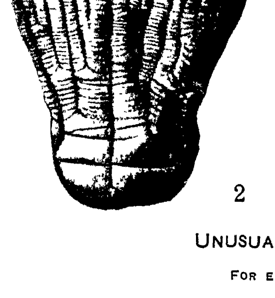

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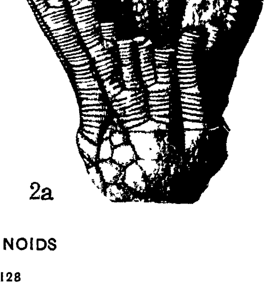

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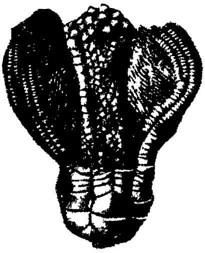
UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 128



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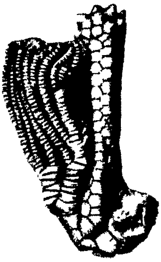

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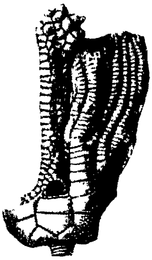

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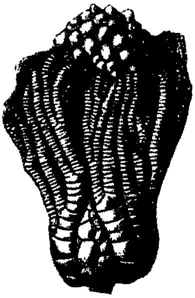

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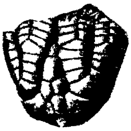

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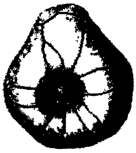

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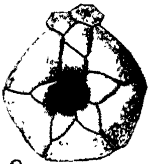

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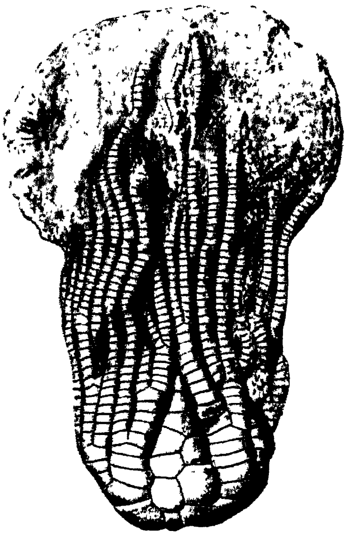

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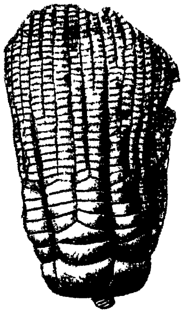

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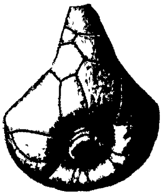

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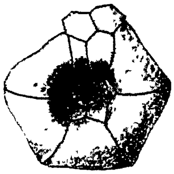

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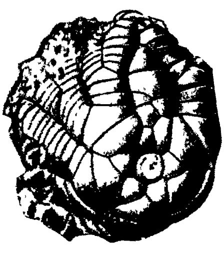

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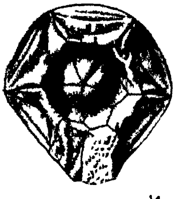

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UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 129

## PLATE 22

All figures natural size

Page

**ZEACRINUS COMMATICUS** S. A. Miller........................ 65, 80

FIG. 1. Posterior view of complete crown, showing mode of arm branching, nodose distal end of sac projecting beyond arms, and arrangement of anal plates as usually seen.

2. Left anterior view of another specimen with sac partially exposed, showing the increased number of IBr in anterior ray.

3. Specimen exposing full length of club-shaped sac, from the posterior side, showing complete succession of plates from the anal area up.

3*a*. Anterior view of same, showing anal opening at base of sac.

Keokuk limestone, upper part; Boonville, Missouri.

**ZEACRINUS MAGNOLIAEFORMIS** (Troost) Hall................ 81

FIG. 4. A maximum specimen, seen from the posterior side, showing form and proportions of crown, and arrangement of anal plates as usually found.

5. A medium sized specimen; anterior view of complete crown, showing the usual arrangement of arms.

6. Lower part of crown of smaller specimen, from the posterior side, showing anal plates.

7. Basal view of detached calyx, with typical arrangement of broad anal area, as seen in about 80 per cent of the specimens; RA elongate and passing down into the basal ring, and post. B truncate; BB large.

8. Similar view of calyx with narrow anal area, as found in about 12 per cent of the specimens; RA short, and post. B acuminate, not connecting with succeeding plate.

9. Another variation of the narrow anal area. BB elongate, petal shaped, as in most of the specimens.

10. Basal view of calyx with broad anal side, showing IBB, and BB entirely within the cavity, exceptionally small.

11. Interior view of calyx, showing the cone of greatly enlarged infrabasals.

Upper Chester, Gasper formation: Huntsville, Alabama.

**ZEACRINUS WORTHENI** Hall................................ 65, 81

FIG. 12. Basal view of specimen with broad anal area, for comparison with *Z. magnoliaeformis*.

Upper Chester, Glen Dean formation; Sloan's Valley, Kentucky.

## PLATE 23

All figures natural size

Page

**ZEACRINUS WORTHENI** Hall................................ 81

FIG. 1. Typical specimen, posterior view, showing the usual contour of crown with arms closely folded; narrow anal area with small basals, posterior basal acuminate, and RA occupying entire width of area above it, as occurs in 55 per cent of the specimens.

2. Posterior view of a similar specimen, with like narrow anal area and small basals.

2*a*. Anterior view of same with three rays removed, exposing three sides of the pyramidal ventral sac, with anal opening midway.

3. L. ant. view of specimen with sac completely exposed, showing opening midway at anterior side; apex of pyramid broken off.

4. Posterior view of another specimen with sac intact; narrow anal area with sharp ridge-like succession of plates following it.

5. Distal view of sac of another specimen vertically compressed, with apex broken.

6. Basal view of a typical specimen with the usual form of anal area.

7. Posterior view of specimen with another form of narrow anal area.

8. Basal and posterior view of maximum specimen with post. basal truncate, and anal area similar to that of *Z. magnoliaeformis*; distribution of arms is well shown.

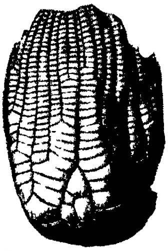
Upper Chester, Glen Dean formation; Sloan's Valley, Kentucky.

**ZEACRINUS GIRTYI.** new species................................ 84

FIG. 9. Posterior view of type, showing wide anal area, truncate post. B, with RA short and broad; and form and proportions of club-shaped sac.

9*a*. Anterior view of same, showing complete succession of arms, and rounded distal end of sac rising beyond their extremities.

Pennsylvanian. Morrow formation; Crittenden, Oklahoma.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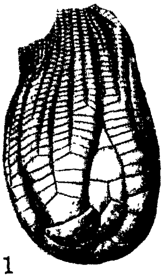
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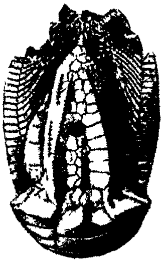
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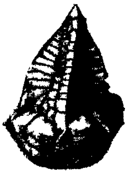
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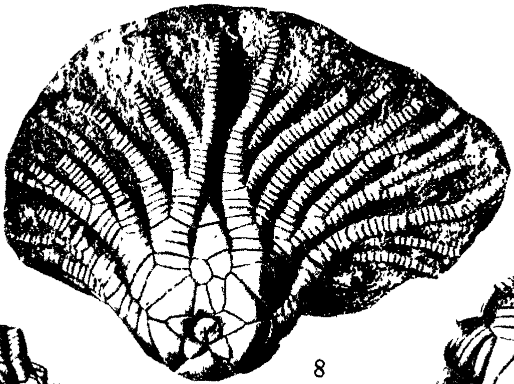
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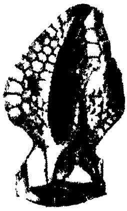
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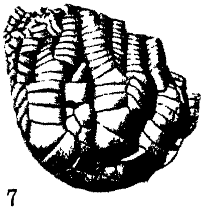
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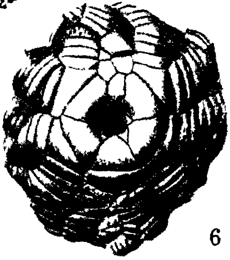
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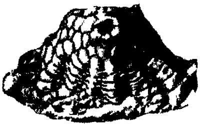
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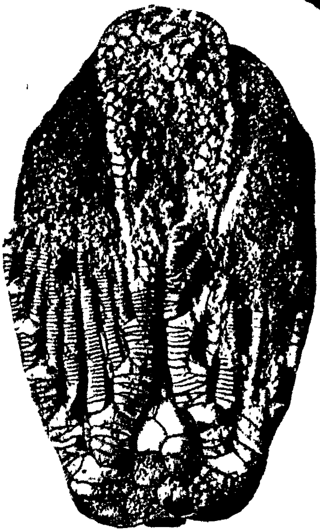
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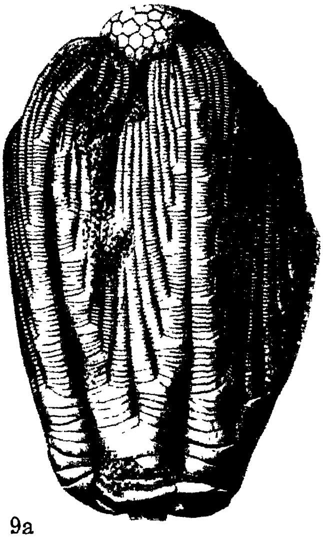
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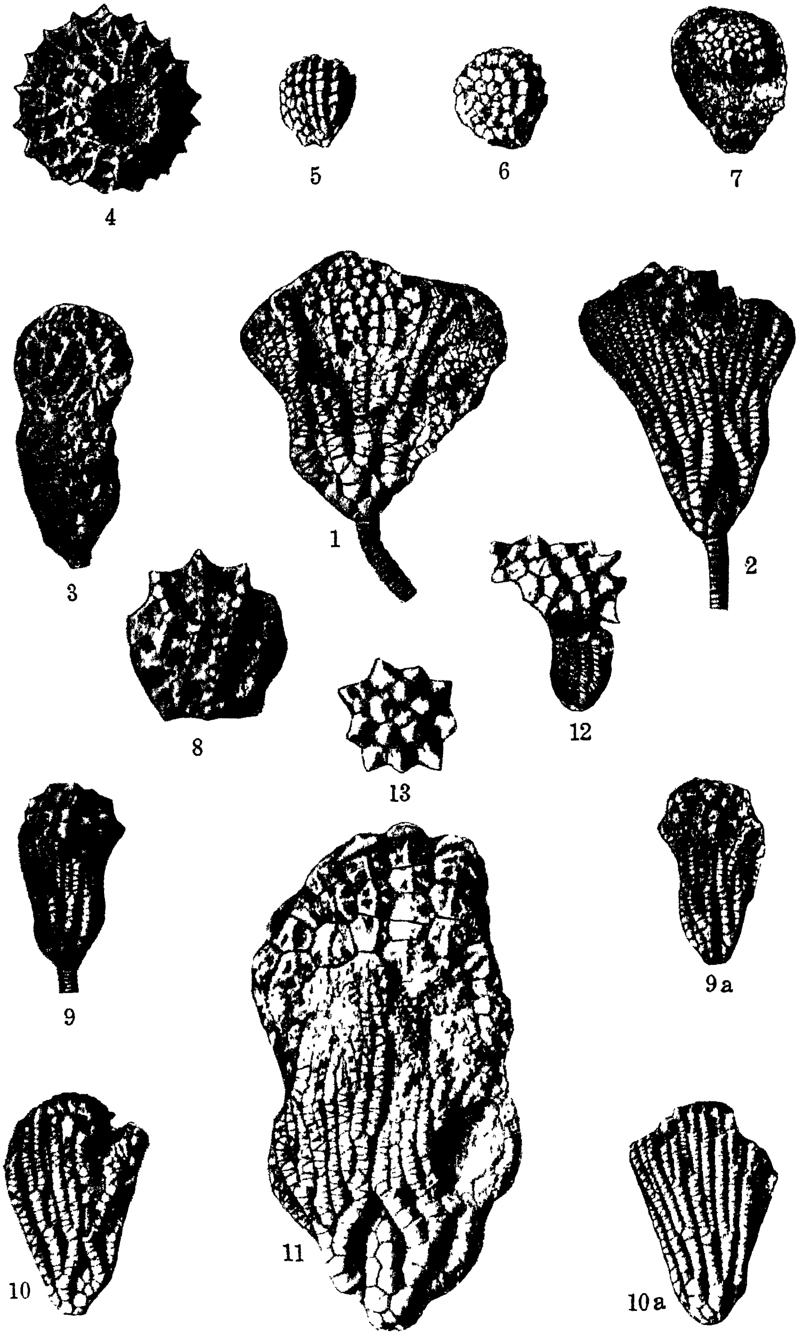
Unusual Forms of Fossil Crinoids

For explanation of plate see page 130



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 131

## PLATE 24

Figures not otherwise noted natural size

| | Page |
|---|---|
| **COELIOCRINUS VENTRICOSUS** (Hall) | 67, 86 |

FIG. 1. The type. Anterior view, showing the inflated sac with plates tending to form longitudinal ridges, and the structure and mode of bifurcation of the arms.

2. Posterior view of another complete crown, showing anal plates leading to the tube, and inflated sac rising above the arms.

3. Lateral view of specimen with most of arms removed, exposing the general form and proportions of the balloon-shaped sac.

4. Proximal view of detached inflated part of sac, showing the narrow neck connecting it with the calyx. (See fig. 1, pl. 25, for opposite view.)

5, 6, 7. Three detached inflated distal ends of sac, showing how they are formed by the bending of the tube, as indicated by the arrangement of plates in longitudinal ridges.

8. Isolated distal end of sac, from Lake Valley, New Mexico. Lower Burlington limestone; all except figure 8 from Burlington, Iowa.

| | |
|---|---|
| **COELIOCRINUS DILATATUS** (Hall) | 86 |

FIGS. 9, 9*a*. The type. Left anterior and right posterior views of complete crown, showing relatively large size of the sac and its distal plates.

10, 10*a*. Posterior and anterior view of similar crown, showing mode of bifurcation of arms.

11. An unusually large specimen; posterior view showing arrangement of anal plates at base of tube, and large size of plates forming the inflated part.

12. Specimen showing distal part of sac with plates tending to become spiniferous.

13. Isolated distal part of a sac from Lake Valley, New Mexico. Lower Burlington limestone; all except figure 13 from Burlington, Iowa.

## PLATE 25

All figures natural size unless otherwise noted

| | Page |
|---|---|
| **COELIOCRINUS VENTRICOSUS** (Hall) | 86 |

FIG. 1. Distal view of inflated ventral sac, same specimen shown on plate 24, fig. 4 (slightly enlarged).

| | |
|---|---|
| **COELIOCRINUS SUBSPINOSUS** White | 86 |

FIG. 2. Lateral view of a maximum crown, with spines projecting from flattened distal end of sac above the region of the arms.

3. Posterior view of smaller specimen with expanded summit of sac fully exposed, showing the numerous plates in the median part, bordered by peripheral spines.

*3a*. Anterior view of same specimen.

Upper Burlington limestone; Burlington, Iowa.

| | |
|---|---|
| **HYDREIONOCRINUS WETHERBYI** Wachsmuth and Springer | 89, 90 |

FIGS. 4, 5, 6, 7, 8. Basal views of several specimens, showing variation in basal and radianal plates; figs. 7 and 8 show the spiniferous axillary IBr in all five rays.

9. Posterior view of crown, showing nodose or spiniferous axillaries.

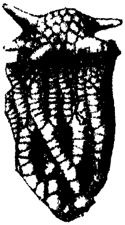
10. Anterior view of crown, showing IBr single and axillary, contrasted with structure of same ray in *H. depressus*.

11. A complete crown, somewhat distorted, with the flattened distal end of the mushroom-shaped sac fully exposed, consisting of 5 spiniferous plates meeting in the middle.

12. A similar crown, with the spiniferous canopy much larger, composed of 7 connected plates, and showing extreme development of the spiniferous primibrachs.

*12a*. Upper side of spiniferous canopy.

Upper Chester, Glen Dean formation; Sloan's Valley, Kentucky, except figure 11, which is from Grayson Springs.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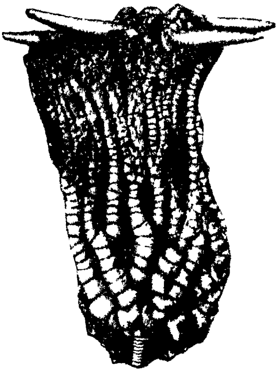
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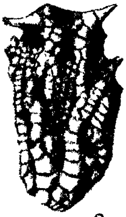
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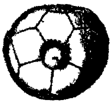
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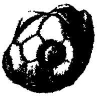
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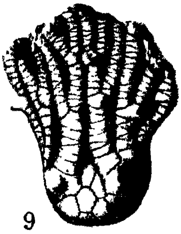
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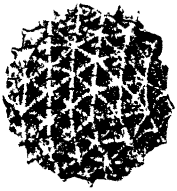
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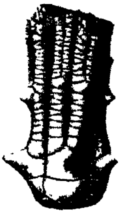
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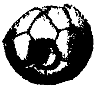
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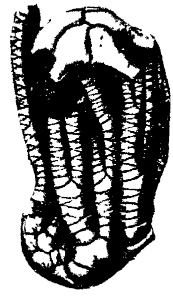
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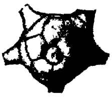
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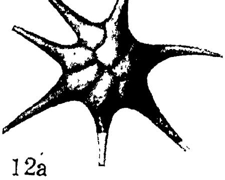
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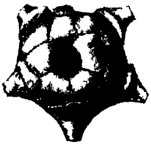
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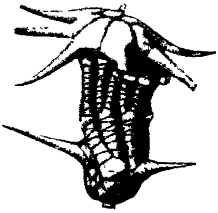
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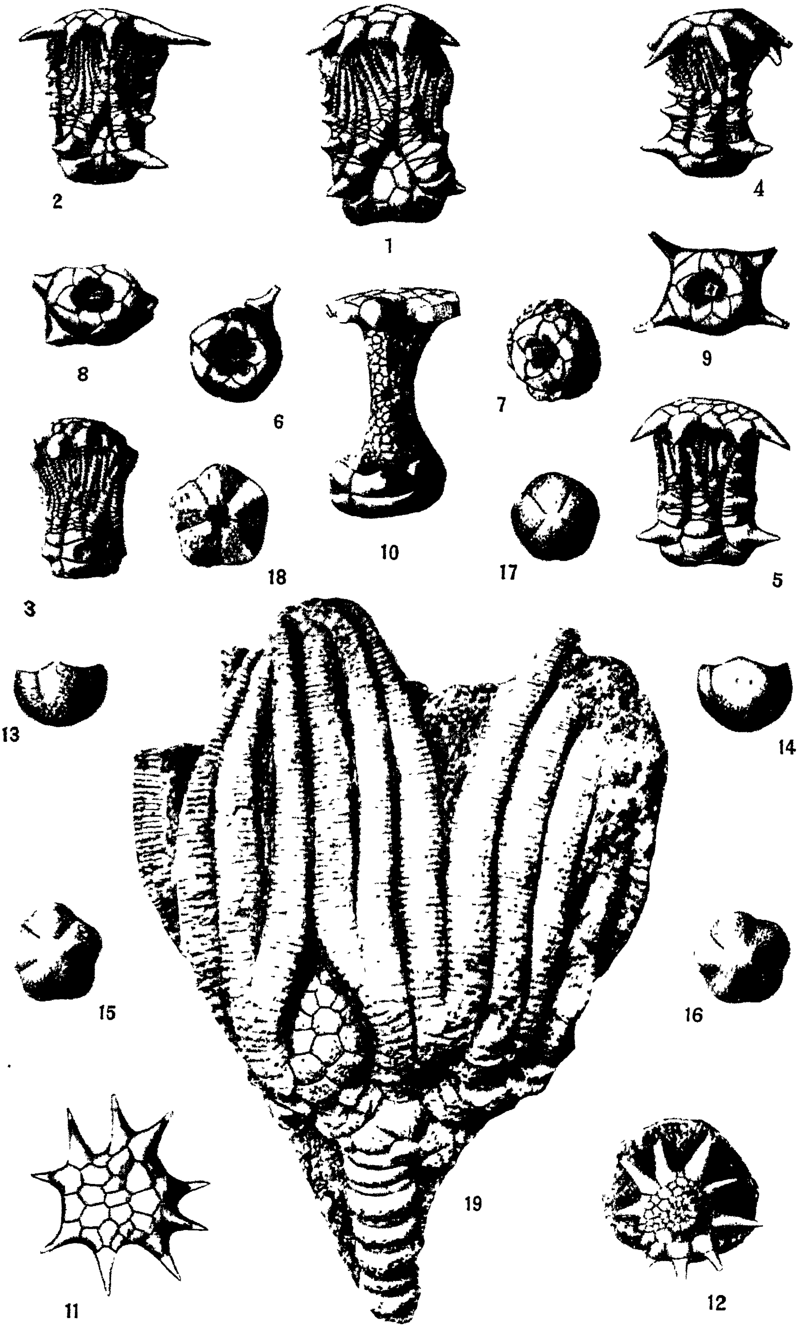
Unusual Forms of Fossil Crinoids

For explanation of plate see page 132



UNUSUAL FORMS OF FOSSIL CRINOIDS

FOR EXPLANATION OF PLATE SEE PAGE 133

## PLATE 26

Figures natural size unless otherwise stated

Page

**HYDREIONOCRINUS DEPRESSUS** (Hall from Troost) ............ 89, 90

FIGS. 1, 2. Posterior views of complete crowns, showing arrangement of anal area, mode of bifurcation of arms, spiniferous axillaries, and flattened distal end of sac surmounting the whole, with spiniferous peripheral plates projecting laterally from the margin exceeding in diameter all the parts below.

3. L. post, view of similar specimen.

4, 5. Anterior views of two similar specimens, showing the nonspiniferous IBr in anterior ray, succeeded by one or more biserial pairs of brachials below the bifurcation.

6, 7, 8. Basal views of three specimens, showing pentagonal stem, and large size of basal cavity as compared with that of *H. wetherbyi*.

9. Basal view of another specimen, showing the spiniferous IBr in the four rays other than the anterior.

10. Anterior view of specimen with arms removed, exposing the entire length of ventral sac, with the anal opening half way up. × $\frac{3}{2}$.

11. Distal view of expanded sac, showing the numerous plates in the median part and spiniferous marginal plates—about 25 in all.

12. The same parts of another specimen, seen from the under side, showing the small size of the tube leading to the calyx.

Upper Chester, Glen Dean formation; Sloan's Valley, Kentucky.

**AGASSIZOCRINUS LOBATUS**, new species ...................... 63

FIGS. 13, 14. Lateral views of infrabasal cone, showing the plates divided in the upper part.

15, 16. Basal views of two other specimens, showing lobation of infrabasal cone, rounded and coalesced at the base, and partially divided above.

17. A similar specimen, with plates almost completely divided. and faint trace of column facet.

18. Distal view of another specimen, showing division of infrabasals, and the axial canals passing down.

Lower part of Upper Chester, Gasper formation; Huntsville, Alabama.

**WOODOCRINUS MACRODACTYLUS** De Koninck ...................... 77

FIG. 19. Posterior view of typical specimen, to show the ponderous arms, extremely short brachials, and large anal area indicating a strong ventral sac.

Upper part of Lower Carboniferous; Richmond, England.

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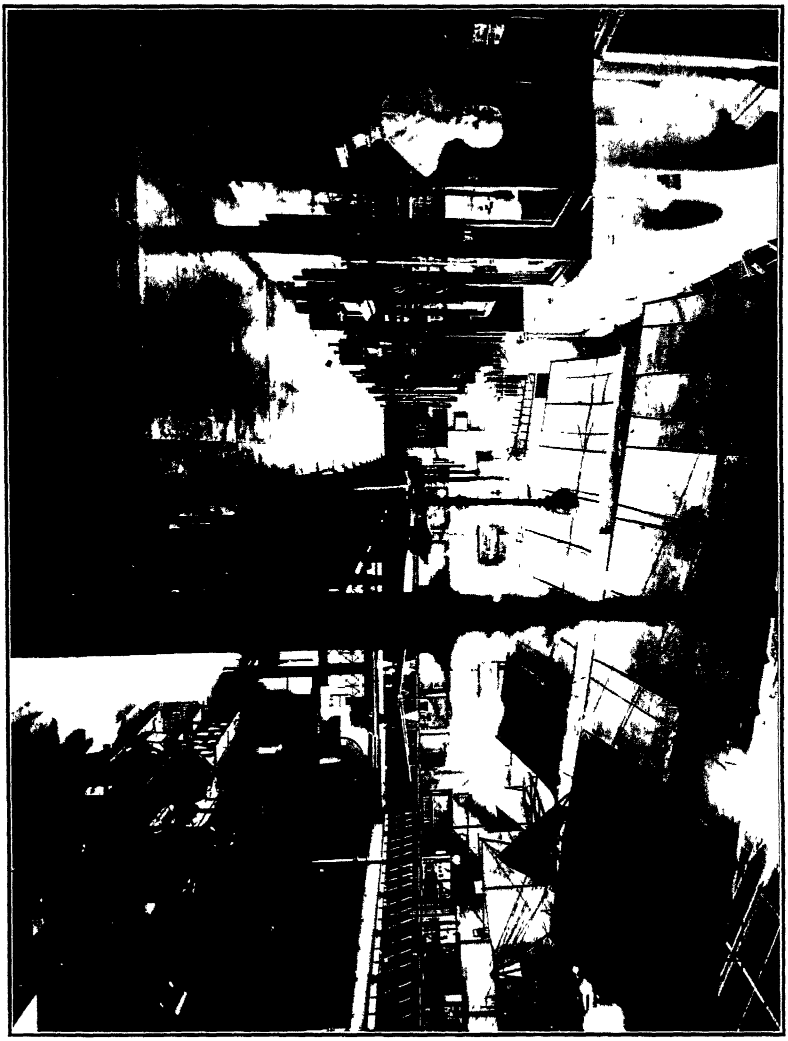
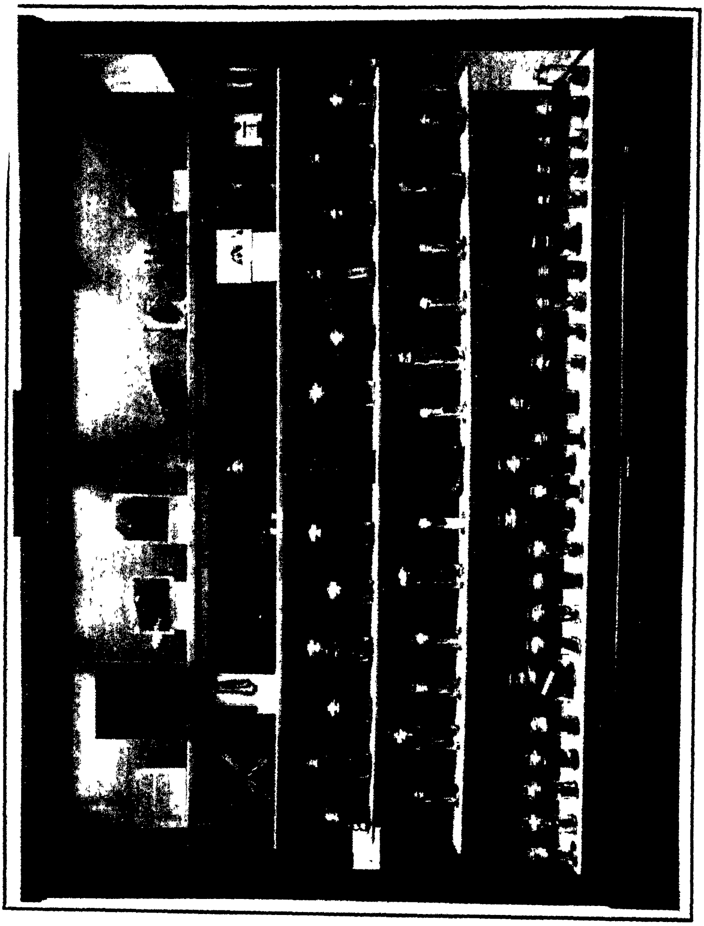


HISTORY OF MEDICINE EXHIBITS—EAST GALLERY

FOR DESCRIPTION OF PLATE SEE PAGE 1



INDIAN MEDICINE EXHIBIT

FOR DESCRIPTION OF PLATE SEE PAGE 1

# THE INDIAN MEDICAL EXHIBIT OF THE DIVISION OF MEDICINE IN THE UNITED STATES NATIONAL MUSEUM

By Charles Whitebread

*Assistant Curator, Division of Medicine, United States National Museum*

## INTRODUCTION

This paper is a continuation of a previous article[1] descriptive of the history of medicine exhibits, published by the Museum to meet the demands of visitors for information, copies of labels, and pictures of specimens of these exhibits. The exhibit of American Indian medicine, herein described, was arranged by the late Dr. James M. Flint, U. S. N., who was for many years honorary curator of the division of medicine, with the assistance and cooperation of representatives of the Bureau of American Ethnology, department of anthropology, and others. The purpose of the exhibit is to illustrate original medical practices of the Indians.

Acting upon the suggestion of Prof. W. H. Holmes, then head curator of the department of anthropology, of which the division of medicine was at that time a unit, Doctor Flint arranged a series of history of medicine exhibits. Magic and psychic medicines were given first place in the series; then followed exhibits illustrating the medical practices of the ancient Egyptians, Greeks, and Romans. The Egyptians, who, according to Pliny, were the originators of the healing art, named mythological deities as the first physicians. The Greeks and Romans also assigned to medicine, as its founders and supporters, ever-ruling gods and goddesses, and the first remedies of the people of these countries were "magic." It is not surprising, then, that the Indians also associated the technique of medicine with the offices of religious worship; that the physicians of this race were connected with the priesthood; or that their remedies were principally magic.

Medical practices were much the same among the various tribes. While nothing attaining to the dignity of a science existed, still in medicine the Indians used faculties as discriminating and arrived at results as important and correct as those achieved by other races in a higher state of cultural advancement.

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[1] Proc. U. S. Nat. Mus., vol. 65, art. 15, no. 2528, 1924, pp. 1–44, figs. 1–24, pls. 1–5.

## RELIGION OF THE INDIANS

The Indians believed in an enormous number of spirits existing throughout nature. These spirits were of varying power, and many tribes entertained the idea of a superior or supreme deity associated with the sky or the sun. This conception is evidently the basis for the notion of a great spirit generally attributed to the Indians by the whites. Some of these spirits were considered wholly good and some wholly bad, but as often, or rather more often, a spirit might be propitious or malevolent depending on circumstances. The Indians recognized these spirits in dreams; in numberless signs and omens among birds and beasts; they heard them talk in tempests; they saw them in dark clouds; they beset them in almost every possible angry sound which the jarring elements made; and they were even embodied in the insects which crept out of the earth.

The idea of magic power, exerted by means of spirits or through other occult powers of nature, was one of the fundamental concepts bearing on the religious life of the Indians. It existed among all the tribes. That this magic power could influence the life of man, and could in turn be influenced by human activity, was the common belief. This belief in magic power being strong in the Indian mind, all his actions were regulated by the desire to maintain control over it.

## MEDICINE OF THE INDIANS

The following, concerning the medicine of the Indians, is from the Bureau of American Ethnology's Bulletin 30, Handbook of American Indians:

> In general the tribes show many similarities in regard to medicine, but the actual agents employed differ with the tribes and localities, as well as with individual healers. Magic, prayers, songs, exhortation, suggestion, ceremonies, fetiches, and certain specifics and mechanical processes are employed only by the medicine men or medicine women; other specific remedies or procedures are proprietary, generally among a few old women in the tribe; while many vegetal remedies and simple manipulations are of common knowledge in a given locality.
>
> The employment of magic consists in opposing a supposed malign influence, such as that of a sorcerer, spirits of the dead, mythic animals, etc., by the supernatural power of the healer's fetiches and other means. Prayers are addressed to benevolent deities and spirits, invoking their aid. Healing songs, consisting of prayers or exhortations, are sung. Harangues are directed to evil spirits supposed to cause the sickness, and often are accentuated by noises to frighten such spirits away. Suggestion is exercised in many ways directly and indirectly. Curative ceremonies usually combine all or most of the agencies mentioned.

## MEDICINE MEN

Each tribe had men who professed to mediate between the world of spirits and the world of men. The designation and functions of these persons differed considerably in the various tribes, but they may be classed roughly as priest-doctors, prophet-doctors, and herbalist doctors.

**Priest-doctors.**—The priest-doctor was a magician and the art which he practiced was magic. In some tribes the men who practiced this art formed into societies or associations. They were admitted by a public ceremony, after having been instructed in private, and given evidence of their skill and fitness. Anyone could become a follower and practicer of this art. The priest-doctors assembled to teach the art of supplicating spirits. These practitioners are to be distinguished from the true priests, whose positions and functions were tribal instead of individual.

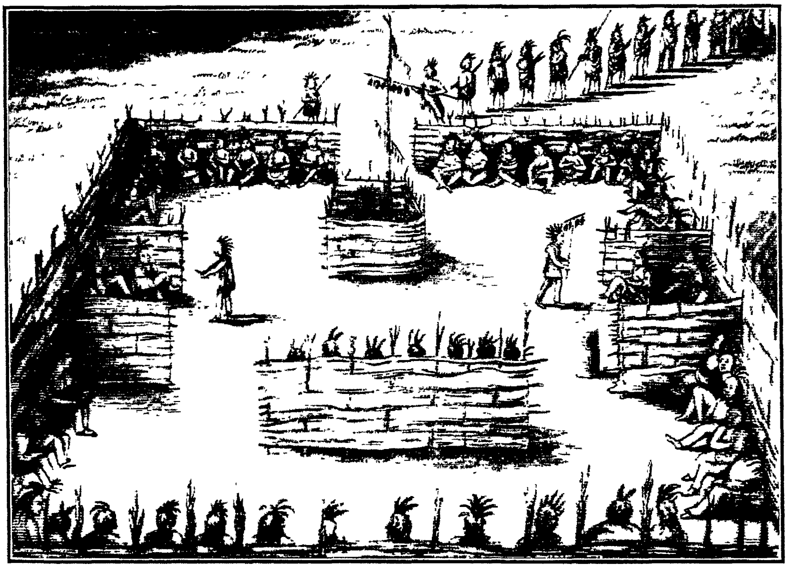

FIG. 1.—PRIEST-DOCTOR'S LODGE

Catlin[2] describes the practice and dress of the medicine man pictured in figure 2 as follows:

> Here is a gentleman who gains laurels without going to war—who stays at home and takes care of the women and children. His fame and influence, which often exceed that of the chief of the tribe, is gained without risk of life, but by a little legerdemain and cunning, which are easily practiced upon a superstitious people, who are weak enough to believe that his mystic arts often produce miracles, and which, like all miracles, are difficult to prove or to disprove.

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[2] Life Amongst the Indians. By George Catlin.

Whilst residing in the American Fur Company's factory at the mouth of the Yellowstone River, on the upper Missouri, I had the opportunity of witnessing a Blackfoot doctor's display, in this identical costume, over a dying patient who breathed his last under his strange and even frightful gesticulations and growls and groans under this skin of a yellow bear—hopping over and over his patient whom he had placed on the ground, and was pawing about with his hands and feet, in the manner that a bear might have done.

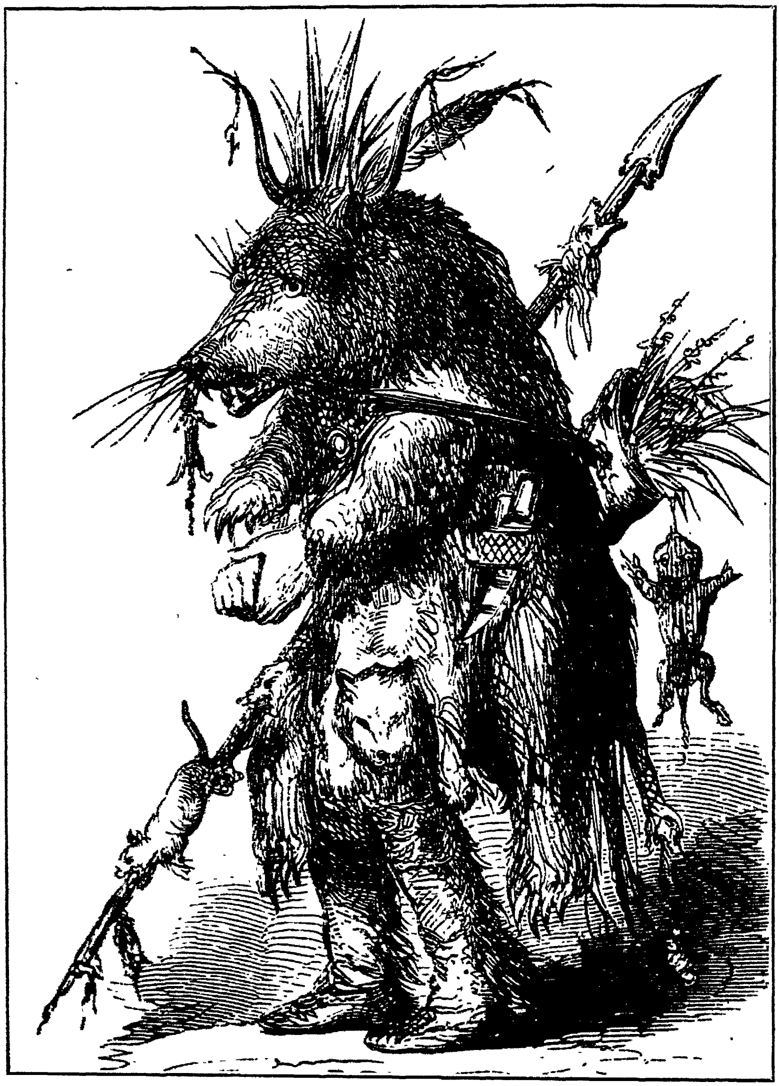

FIG. 2.—A BLACKFOOT PRIEST-DOCTOR

Each one of these Indian physicians, during his lifetime of practice, conjures up and constructs some frightful conception for his medicine dress, strung with skins of deformed animals, reptiles, and birds; the hoofs of animals, the claws and toenails of birds, the skins of frogs, of toads, of bats, and everything else that he can gradually gather, to consummate ugliness of looks and frightfulness of sounds by their grating and rattling noises as he dances underneath them, with his face hidden, adding to them the frightful flats and sharps of his growling and squeaking voice, and the stamping of his feet as he dances and jumps over and around his dying patient.

The doctor never puts on this frightful dress until he goes to pay his last visit to his patient, and when he moves through the village with this dress on it is known to all the villagers that the patient is dying; and from sympathy, as well as from a general custom, they all gather around in a crowd to witness the ceremony; and all, with the hand over the mouth, commence crying and moaning in the most pitiable manner.

**Prophet-doctors.**—The art of the Indian prophet was practiced alone, by solitary and distinct individuals who had no associates. Prophets sprang up at long intervals and far apart among the Indian tribes. They professed to be under supernatural power and to be filled with a divine afflatus. The art which they practiced resembled that of the priest-doctors, differing chiefly in the object sought. The priest-doctor sought to control or influence events; the prophet to predict them. Both applied to spirits for their power. Both used material substances, such as stuffed birds, bones, etc., as objects by or through which the secret energy was to be exercised. The general modes of operation were similar. The seventh annual report of the Bureau of American Ethnology contains the following with reference to Indian prophets among the Ojibwa Indians:

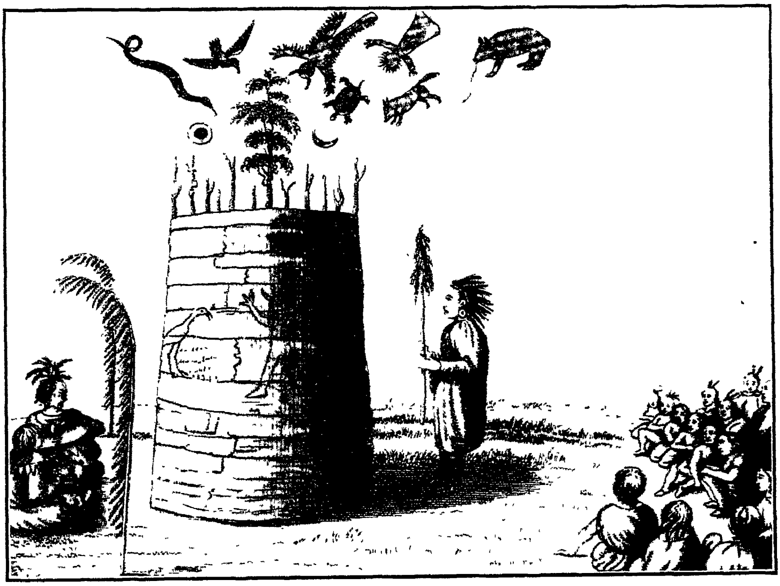

FIG. 3.—INDIAN PROPHET'S LODGE

> The jessakkid is a seer and prophet; though commonly designated a "juggler," the Indians define him as a "revealer of hidden truths." There is no

association whatever between the members of this profession, and each practices his art singly and alone whenever a demand is made and the fee presented. As there is no association, so there is no initiation by means of which one may become a jessakkid. The gift is believed to be given by the thunder god, and then only at long intervals and to a chosen few. * * * The exorcism of demons is one of the chief pretentions of this personage, and evil spirits are sometimes removed by sucking them through tubes. * * * (See figs. 4 and 12.) The lodge (fig. 3) used by this class of men consists of four poles planted in the ground, forming a square of 3 or 4 feet and upward in diameter, around which are wrapped birch bark, robes, or canvas in such a way as to form an upright cylinder. * * * When the prophet has seated himself within his lodge the structure begins to sway violently from side to side, loud thumping noises are heard within, denoting the arrival of spirits, and numerous voices and laughter are distinctly audible to those without. Questions may then be put to the prophet and, if everything be favorable, the response is not long in coming."

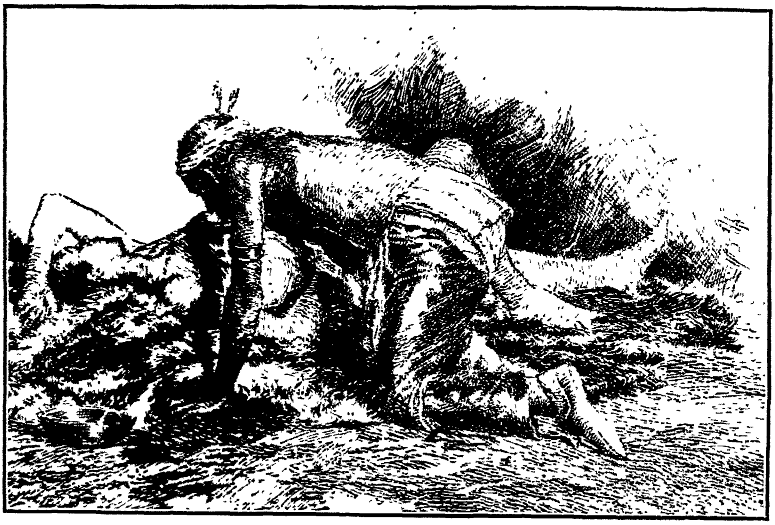

FIG. 4.—MEDICINE MAN REMOVING DISEASE

**Herbalist doctors.**—These persons, men and women, were the real physicians of the tribes. They administered liquid and dry medicines, bled patients, cupped with a horn, and operated on ulcers, swellings, wounds, etc. Although herbalists were aware that certain plants, roots, etc., would produce a definite effect upon the human system, they attributed any benefit obtained therefrom to the fact that the remedies were distasteful and injurious to the demons in the system and to whom the disease was attributed.

In figure 5 the doctor is seated upon a mat inside of a rude tent, holding between his feet a vessel, the contents of which he is stirring with his right hand; with his left hand he shakes a rattle, meantime reciting certain incantations whereby he potentizes his drugs. Figure 6 pictures the doctor, seated by the side of a sick man, shaking a rattle and invoking the assistance of friendly spirits to drive out the malicious spirits which are causing the sickness. A bowl of medicine (fig. 14) is at hand which the doctor usually sprinkles or blows upon the patient in the intervals of the invocations.

## ORIGIN OF DISEASE AND MEDICINE

The Indians believed that disease was not natural, but was due to the evil influence of animal spirits, ghosts, witches, etc., or to the absence of the soul. Some tribes believed in several souls, the loss of one of which caused partial loss of life, that is, sickness, while the loss of all, or of the principal one, entailed death.

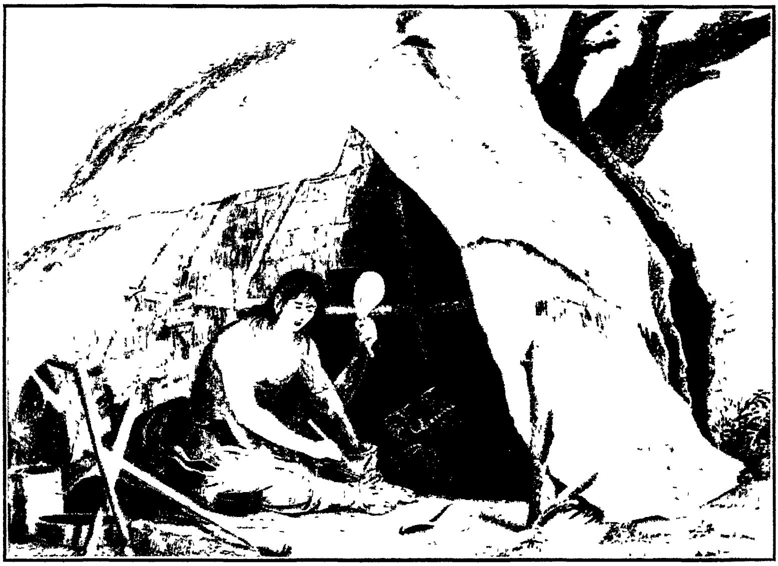

FIG. 5.—HERBALIST DOCTOR PREPARING MEDICINE

Mooney in his Sacred Formulas of the Cherokees gives the following interesting account of this particular tribe's belief concerning the origin of disease and medicine:

> In the old days quadrupeds, birds, fishes, and insects could all talk, and they and the human race lived together in peace and friendship. But as time went on the people increased so rapidly that their settlements spread over the whole earth and the poor animals found themselves beginning to be cramped for room. This was bad enough, but to add to their misfortunes man invented bows, knives, blowguns, spears, and hooks, and began to slaughter the larger animals, birds, and fishes for the sake of their flesh or their skins, while the smaller creatures, such as the frogs and worms, were crushed and trodden upon without mercy, out of pure carelessness or contempt. In this state of affairs the animals resolved to consult upon measures for their common safety.

The bears were the first to meet in council in their town house in Kuwahi, the "Mulberry Place," and the old White Bear Chief presided. After each in turn had made complaint against the way in which man killed their friends, devoured their flesh and used their skins for his own adornment, it was unanimously decided to begin war at once against the human race. Some one asked what weapons man used to accomplish their destruction. "Bows and arrows, of course," cried all the bears in chorus. "And what are they made of?" was the next question. "The bow of wood and the string of our own entrails."

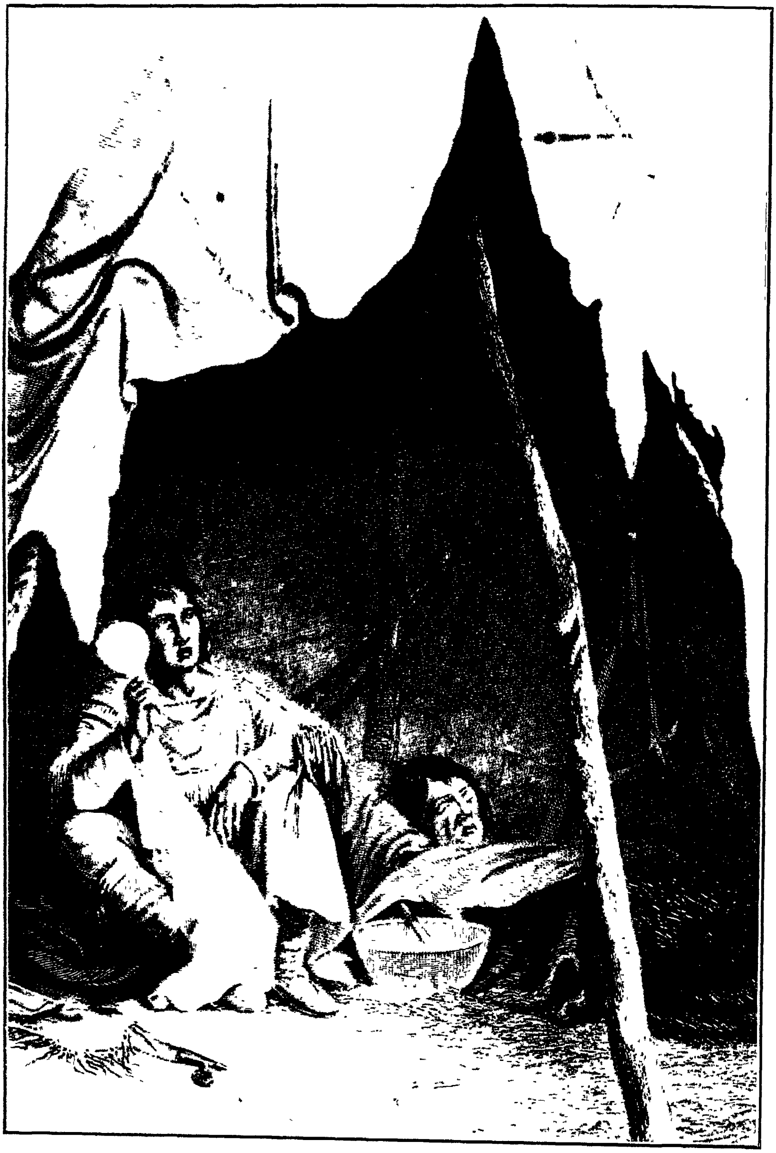

FIG. 6.—MEDICINE MAN ADMINISTERING TO PATIENT

replied one of the bears. It was then proposed that they make a bow and some arrows and see if they could not turn man's weapons against himself. So one bear got a nice piece of locust wood and another sacrificed himself for the good of the rest in order to furnish a piece of his entrails for the string. But when everything was ready and the first bear stepped up to make the trial it was found that in letting the arrow fly after drawing back the bow his long claws caught the string and spoiled the shot. This was annoying, but another suggested that he could overcome the difficulty by cutting his claws, which was accordingly done, and on a second trial it was found that the arrow went straight to the mark. But here the chief, the old White Bear, interposed and said that it was necessary that they should have long claws in order to be able to climb trees. " One of us has already died to furnish the bowstring and if we now cut off our claws we shall all have to starve together. It is better to trust to the teeth and claws which nature has given us, for it is evident that man's weapons were not intended for us."

No one could suggest any better plan, so the old chief dismissed the council and the bears dispersed to their forest haunts without having concerted any means for preventing the increase of the human race. Had the results of the council been otherwise, we should now be at war with the bears, but as it is the hunter does not even ask the bear's pardon when he kills one.

The deer next held a council under their chief, the Little Deer, and after some deliberation resolved to inflict rheumatism upon every hunter who should kill one of their number, unless he took care to ask their pardon for the offense. They sent notice of their decision to the nearest settlement of Indians and told them at the same time how to make propitiation when necessity forced them to kill one of the deer tribe. Now, whenever the hunter brings down a deer, the Little Deer, who is swift as the wind and can not be wounded, runs quickly up to the spot and bending over the bloodstains asks the spirit of the deer if it has heard the prayer of the hunter for pardon. If the reply be "Yes" all is well and the Little Deer goes on his way, but if the reply be in the negative he follows on the trail of the hunter, guided by the drops of blood on the ground, until he arrives at the cabin in the settlement, when the Little Deer enters invisibly and strikes the neglectful hunter with rheumatism, so that he is rendered on the instant a helpless cripple. No hunter who has regard for his health ever fails to ask pardon of the deer for killing it, although some who have not learned the proper formula may attempt to turn aside the Little Deer from his pursuit by building a fire behind them in the trail.

Next came the fishes and reptiles, who had their own grievances against humanity. They held a joint council and determined to make their victims dream of snakes twining about them in slimy folds and blowing their fetid breath in their faces, or to make them dream of eating raw or decaying fish, so that they would lose appetite, sicken, and die. Thus it is that snake and fish dreams are accounted for.

Finally the birds, insects, and smaller animals came together for a like purpose, and the grubworm presided over the deliberations. It was decided that each in turn should express an opinion and then vote on the question as to whether or not man should be deemed guilty. Seven votes were to be sufficient to condemn him. One after another denounced man's cruelty and injustice toward the other animals and voted in favor of his death. The frog spoke first and said: "We must do something to check the increase of the race or people will become so numerous that we shall be crowded from off the earth. See how man has kicked me about because I'm ugly, as he says, until my back is covered with sores;" and here he showed the spots on his skin. Next came the bird, who condemned man because "he burns my feet off," alluding to the way in which the hunter barbecues birds by impaling them on a stick set over the fire, so that their feathers and tender feet are singed and burned. Others followed in the same strain. The ground squirrel alone ventured to say a word in behalf of man, who seldom hurt him because he was so small; but this so enraged the others that they fell upon the ground squirrel and tore him with their teeth and claws, and the stripes remain on his back to this day.

The assembly then began to devise and name various diseases, one after another, and had not their invention finally failed them not one of the human race would have been able to survive. The grubworm in his place of honor hailed each new malady with delight, until at last they had reached the end of the list, when some one suggested that it be arranged so that menstruation should sometimes prove fatal to woman. On this he rose up in his place and cried: "Thanks! I'm glad some of them will die, for they are getting so thick that they tread on me." He fairly shook with joy at the thought, so that he fell over backward and could not get on his feet again, but had to wriggle off on his back, as the grubworm has done ever since.

When the plants, who were friendly to man, heard what had been done by the animals, they determined to defeat their evil designs. Each tree, shrub, and herb, down even to the grasses and mosses, agreed to furnish a remedy for some of the diseases named, and each said: "I shall appear to help man when he calls upon me in his need." Thus did medicine originate, and the plants, every one of which has its use if we only knew it, furnish the antidote to counteract the evil wrought by the revengeful animals. When the doctor is in doubt what treatment to apply for the relief of a patient, the spirit of the plant suggests to him the proper remedy.

## INDIAN THEORIES OF DISEASE

The Indians believed that disease was caused by:

1. A malevolent spirit which assumed material form either animate or inanimate and attacked the victim with or without provocation.
2. A spirit, or an object supernaturally injected into a person, which acted at the suggestion of a human enemy who possessed supernatural powers.
3. The angered spirits of the dead, or those of animals, plants, and other natural objects.
4. Absence of the patient's soul.

## ARRANGEMENT OF EXHIBITS

**Magic medicine.**—Exorcism; Invocation; Incantation; Amulets and charms; Talismans; Fetiches; Transference of disease; Signatures; Evil eye.

**Pharmacological medicine.**—Some drugs of the Indians.

**Surgical medicine.**—Sudatory (sweat) bath; Venesection; Cupping; Cautery.

## MAGIC MEDICINE

Magic is the "pretended art of producing supernatural effects by bringing into play the action of supernatural beings, of departed spirits, or of the occult powers of nature." The application of magic to the treatment of disease is magic medicine, exerted through gods or demons, disembodied spirits of men, animals, plants, or minerals, or by occult powers residing in certain natural objects.

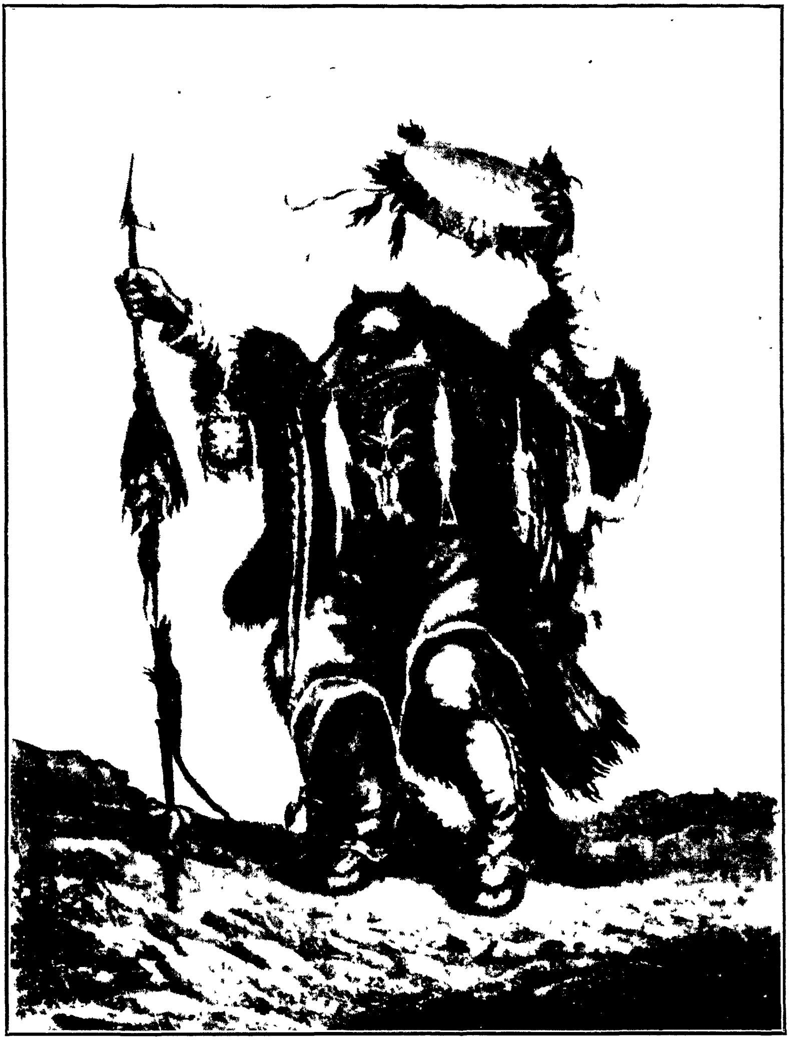

FIG. 7.—SIOUX MEDICINE MAN

Type specimens, and descriptive information, illustrating how the Indians brought these magic agents and influences into action for the cure of disease are assembled in the exhibit under the head of magic medicine.

**Exorcism.**—Exorcism is the practice of casting out evil spirits by religious or magic formulas or ceremonies. The Indian medicine man, in the exercise of the function of physician, strove to exorcise the malignant spirits by means of intimidation or cajolery, or through the intervention of friendly spirits more powerful than the disease spirit.

*Sioux medicine man.*—Picture of the costume worn by the medicine man or priest-doctor while exorcising the evil spirits of disease. Clad in the skin and mask of a bear with pendants of various small animals, he carries in one hand a drum, and in the other a spear with a carved and decorated shaft (fig. 7). Cat. No. 143117, U.S.N.M.

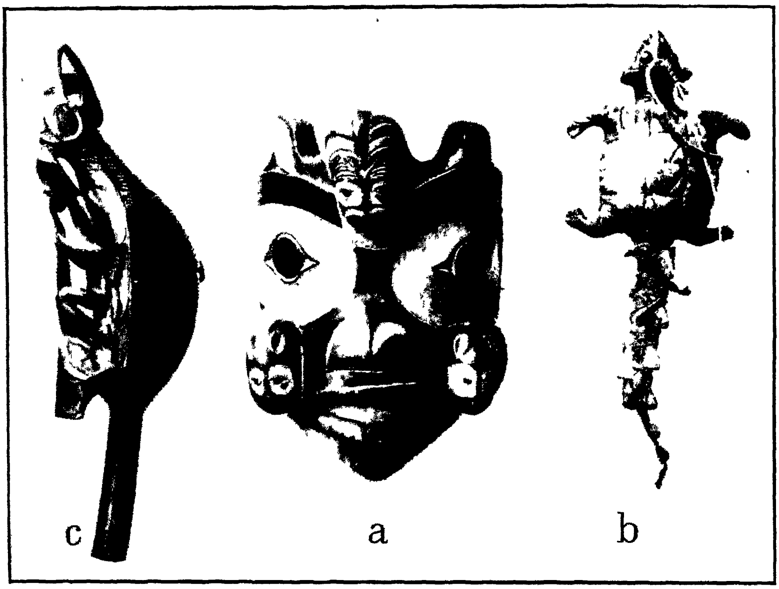

FIG. 8.—ANIMAL MASK AND RATTLES

*Mask.*—Worn by Indian medicine man in the practice of exorcism (fig. 8*a*). Cat. No. 67957, U.S.N.M.

*Turtle rattle.*—Used by Indian medicine man in the practice of exorcism (fig. 8*b*). Cat. No. 165848, U.S.N.M.

*Raven rattle.*—A hollow wooden figure, carved in imitation of a raven, bearing upon its back a recumbent figure representing a sick man, from whose mouth another raven is drawing out the materialized spirit of disease. The cavity of the bird contains numerous small pebbles. Used by the medicine men in Alaska, while preparing medicine and in the ceremony of exorcism (fig. 8*c*). Cat. No. 9256, U.S.N.M.

**Invocations.**—Invocations are among the oldest, most persistent, and most universally practiced means employed for the cure of disease. Prayers invoking the assistance of disembodied spirits of men or animals were commonly used by the Indians as an accompaniment of other remedial agencies.

*Indian invocation.*—For the cure of rheumatism. The common belief of the Cherokee Indians regarding rheumatism is that it is caused by the revengeful spirits of slain animals, especially deer. The disease can only be driven out by some more powerful animal spirit. The doctor invokes the aid of the red dog of the east, the blue dog of the north, the black dog of the west, the white dog of the south, and finally the white terrapin of the mountain, in separate prayers. While reciting the prayers the doctor rubs the afflicted part with a warm solution of fern roots and at the end of each he blows once upon the part.

The invocation is as follows:

"Listen! Ha! In the Sun Land you repose, O Red Dog. O now you have swiftly drawn near to hearken. O great adawehi, you never fail in anything. O, appear and draw near running, for your prey never escapes. You are now come to remove the intruder. Ha! You have settled a very small part of it far off there at the end of the earth.

"Listen! Ha! In the Frigid Land you repose, O Blue Dog. O now you have swiftly drawn near to hearken. O great adawehi, you never fail in anything. O, appear and draw near running, for your prey never escapes. You are now come to remove the intruder. Ha! You have settled a very small part of it far off there at the end of the earth.

"Listen! Ha! In the Darkening Land you repose, O Black Dog. O now you have swiftly drawn near to hearken. O great adawehi, you never fail in anything. O, appear and draw near running, for your prey never escapes. You are now come to remove the intruder. Ha! You have settled a very small part of it far off there at the end of the earth.

"Listen! On Wahala you repose, O White Dog. Oh, now you have swiftly drawn near to hearken. O great adawehi, you never fail in anything. O, appear and draw near running, for your prey never escapes. You are now come to remove the intruder. Ha! You have settled a very small part of it far off there at the end of the earth.

"Listen! On Wahala you repose, O White Terrapin. O, now you have swiftly drawn near to hearken. O great adawehi, you never fail in anything. Ha! It is for you to loosen its hold on the bone. Relief is accomplished."

Mooney's Sacred Formulas of the Cherokees.

Cat. No. 143087, U.S.N.M.

**Incantations.**—Magical words or phrases recited or sung. The use of incantations arose from the belief that maladies had a superhuman origin. The ceremonial use of words, verses, songs, etc., as incantations were commonly used by the Indians to prevent and cure disease.

Schoolcraft gives the following as a specimen of the chants used by a Dakotah medicine man:

Flying godlike, I encircle the heavens.
I enlighten the earth to its center,
The little ox (the struggling patient) lies struggling on the earth,
I lay my arrow on the string.

The manner of the doctor who used this incantation was such as to impress the patient that he (the doctor) was conscious that it expressed his own abilities.

**Amulets and charms.**—All races have trusted largely to amulets and charms for the prevention and treatment of diseases. They are objects to which is attributed magical influence or power, so as to fascinate or to help or protect.

Charms for preventing or curing disease were the common resort of the Indians. These charms were of various kinds; generally from the animal or mineral kingdom, but sometimes from the vegetable kingdom.

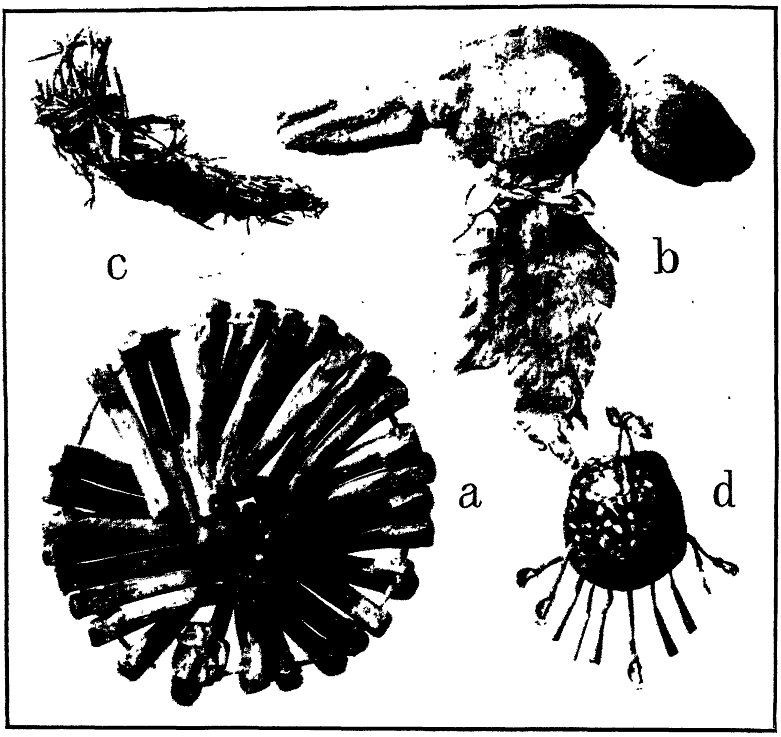

FIG. 9.—AMULETS AND CHARMS

*Amulet.*—Bear's claws strung upon a deerskin thong. Frequently worn as a necklace by the American Indians (fig. 9*a*). Cat No. 143098, U.S.N.M.

*Pah Ute Indian amulet.*—A deerskin pouch divided into three pockets, one containing the leaves of a shrub, another a root, and the third shredded bark. Worn by the Pah Utes as a protective against disease and accident (fig. 9*b*). Cat. No. 19069, U.S.N.M.

*Klamath Indian amulet.*—Twigs of a shrub bound together with strips of bark. Worn suspended from the neck (fig. 9*c*). Cat. No. 24129, U.S.N.M.

*Cheyenne Indian amulet.*—A shell of a box tortoise, with pendants of small shells and metal drops (fig. 9d). Cat. No. 165954, U.S.N.M.

**Talismans.**—Talismans are material objects, which are supposed to work wonders whether kept in one's possession or not.

*Talisman.*—A bunch of white feathers, stained with red paint. One of the numerous articles comprising the paraphernalia of an Indian medicine man (fig. 10). Cat. No. 143099. U.S.N.M.

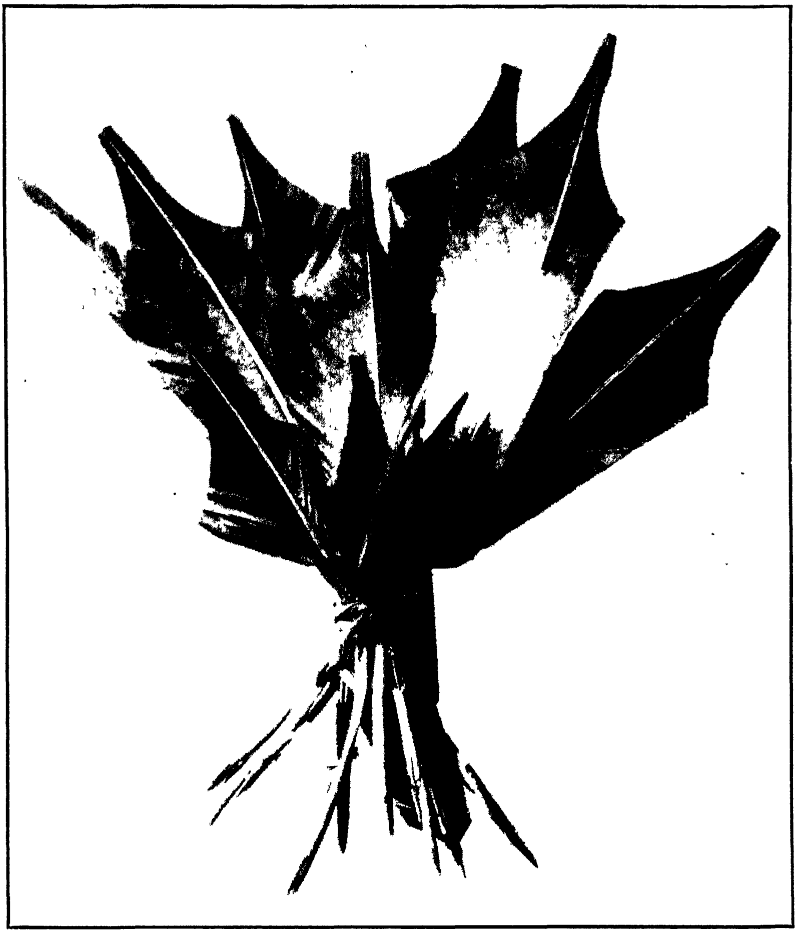

FIG. 10.—TALISMAN

**Fetiches.**—Material objects believed to be the dwelling of a spirit, or to represent a spirit, that may be induced or compelled to help the possessor.

*Alaskan Indian fetich.*—Carved out of a block of wood in imitation of a naked Indian in the attitude of, and probably impersonating, a quadruped. One of the articles composing the outfit of an Alaskan Indian medicine man (fig. 11*a*). Cat. No. 143105, U.S.N.M.

*Zuni fetich.*—A clay image of the mountain lion. The spirit of the mountain lion guards the north, and is master of the gods of the hunt. The hunter makes invocation to the indwelling spirit of this image for assistance in the pursuit of game, and for protection against injury (fig. 11*b*). Cat. No. 128669, U.S.N.M.

*Indian fetich.*—A beaver's tooth suspended by a deerskin strap, the lower part of which is ornamented with minute beads of various colors. Like other fetiches, this is used to cause or cure disease. The medicine man often pretends to extract some of these teeth from the body of the sick man, thus curing the disease by removing the cause (fig. 11*c*). Cat. No. 143489 U.S.N.M.

**Transference of disease.**—The medicine men of the Indians frequently treated by means of suction. Sometimes the medicine men were believed to have gods in their bodies in the form of lizards, frogs, leeches, tortoises, snakes, etc., which served as suction pumps in extracting disease. When an Indian doctor was to operate upon a suffering patient, he placed the sufferer upon a blanket on the ground with the body almost naked. After chants, prayers, the use of the rattle, and many other ceremonies, the doctor got down on his knees and applied suction to the affected part. After sucking thus for a considerable time, the doctor would arise to his feet in apparent agony, groaning, pounding his sides, writhing, and holding a dish of water to his mouth, he proceeded with a singsong bubbling to deposit in the dish the disease which had been drawn from the sick person (figs. 4 and 12).

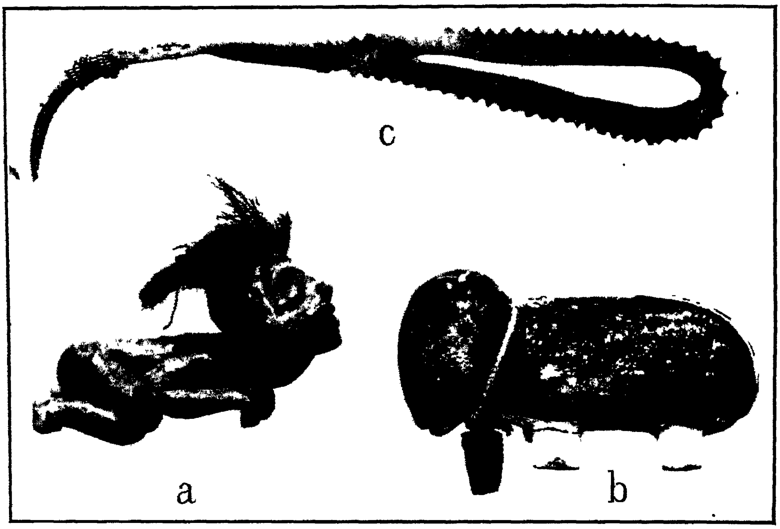

FIG. 11.—FETICHES

*Bone tube.*—An instrument used by the medicine man, by means of which he sucked out with his mouth the cause of disease from the body of the patient. The doctor pretended to swallow the bone tube, and after a time to vomit it together with the poison of the disease (figs. 4 and 12). Cat. No. 141167, U.S.N.M.

**Signatures.**—Some outward sign appearing upon plants and other objects believed to indicate their medicinal use. The belief in European countries was that the Creator in providing herbs for the service of man had stamped on them, at least in many instances, an unmistakable sign of their special remedial value. In most cases the Indians selected the remedy by some imaginary relation between the physical qualities of the drug and the symptoms of the disease. For a disease caused by the rabbit the antidote must be a plant called rabbit's foot, rabbit's ear, or rabbit's tail; for snake dreams the plant used is snake's tooth; for worms a plant resembling a worm in appearance, and for inflamed eyes a flower having the appearance and name of deer's eye.

*Maidenhair fern (Adiantum pedatum).*—Used either in decoction or poultice for rheumatism, generally in connection with some other fern. The doctors explain that the fronds of ferns are curled up in the young plant but unroll and straighten out as it grows, consequently a decoction of ferns causes the contracted muscles of the rheumatic patient to unbend and straighten out in like manner (fig. 13). Cat. No. 143490, U.S.N.M.

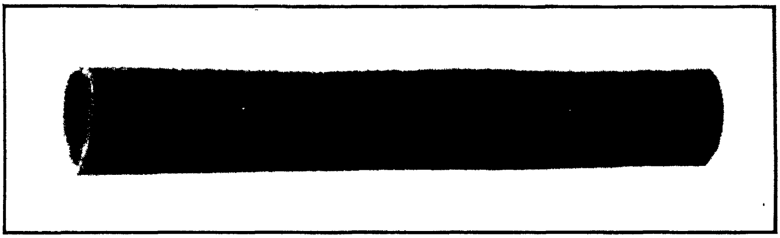

FIG. 12.—BONE TUBE

**Evil eye.**—The belief in the power of some persons to bring misfortune, sickness, and even death to men or animals by gazing at them is one of the most ancient, widespread, and persistent of human superstitions. This belief was universal among savage and partly civilized people everywhere. A belief prevailed among the Indians that the medicine man possessed powers of conjuration and a godlike power of killing those against whom he might hurl his direful charms or glances. The Indians would hide or avert their heads in the presence of medicine men to escape their glances.

*Horns.*—Horns, in one form or another, were of all objects the most common defense against the evil eye. The North American Indians wore horns to ward off that awful, universal, unescapable, mystic glance that has continually harassed man in all quarters of the globe (fig. 17). Cat. No. 143503 U.S.N.M.

## PHARMACOLOGICAL MEDICINE

The Indians practiced a sort of domestic or empirical medicine in which drugs were the principal agents. But even in this method of treatment the selection of the remedy was more often determined by some imaginary relation between the physical qualities of the drug and the symptoms of the disease than by proof of its efficacy. The knowledge possessed by the Indians concerning plants and their therapeutic uses was superficial, and the popular impression regarding the medical skill of the Indian doctor in this respect is erroneous.

The following concerning animal, mineral, and vegetable drugs used by the Indians is from the Bureau of American Ethnology's Bulletin 30, Handbook of American Indians:

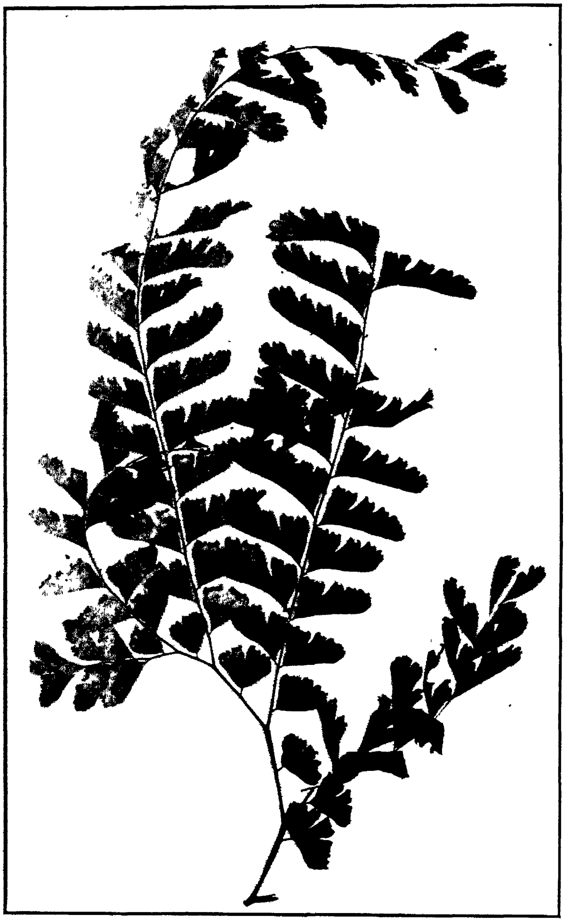

FIG. 13.—MAIDENHAIR FERN

> Vegetal medicines were, and in some tribes still are, numerous. Some of these are employed by reason of a real or fancied resemblance to the part affected, or as fetiches, because of a supposed mythical antagonism to the cause of the sickness. Thus, a plant with a wormlike stem may be given as a vermifuge; one that has many hairlike processes is used among the Hopi

to cure baldness. Among the Apache the sacred tule pollen known as *ha-dn-tin* is given or applied because of its supposed supernatural beneficial effect. Other plants are employed as remedies simply for traditional reasons, without any formulated opinion as to their modes of action. Finally, all the tribes are familiar with and employ cathartics and emetics; in some instances also diaphoretics, diuretics, cough medicines, etc. Every tribe has also knowledge of some of the poisonous plants in its neighborhood and their antidotes.

The parts of plants used as medicines are most often roots, occasionally twigs, leaves, or bark, but rarely flowers or seeds. They are used either fresh or dry, and most commonly in the form of a decoction. Of this a considerable quantity, as much as a cupful, is administered at a time, usually in the morning. Only exceptionally is the dose repeated. Generally only a single plant is used, but among some Indians as many as four plants are combined in a single medicine; some of the Opata mix indiscriminately a large number of substances. * * * Some of the plants, so far as they are known, possess real medicinal value, but many are quite useless for the purpose for which they are prescribed.

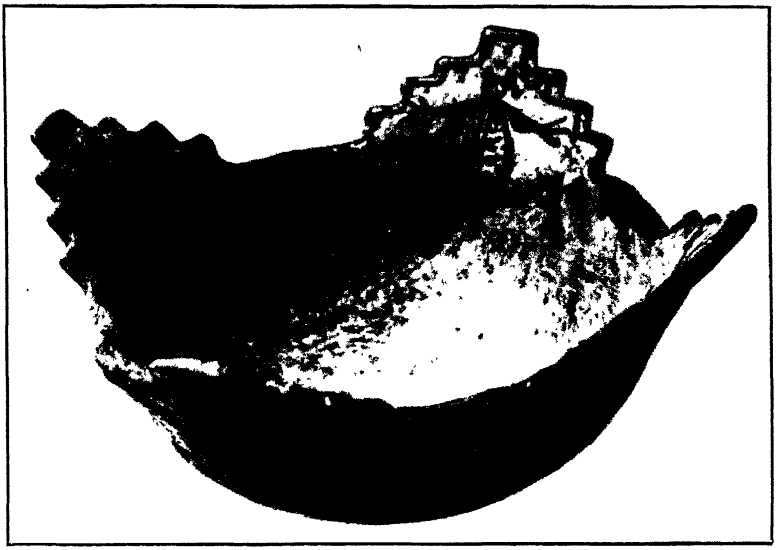

FIG. 14.—MEDICINE BOWL

Animal and mineral substances are also occasionally used as remedies. Among Southwestern tribes the bite of a snake is often treated by applying to the wound a portion of the ventral surface of the body of the same snake. The Papago use crickets as medicine: the Tarahumare, lizards; the Apache, spider's eggs. Among the Navaho and others red ocher combined with fat is used externally to prevent sunburn. The red, barren clay from beneath a campfire is used by the White Mountain Apache women to induce sterility; the Hopi blow charcoal, ashes, or other products of fire on an inflamed surface to counteract the supposed fire which causes the ailment. Antiseptics are unknown, but some of the cleansing agents or healing powders employed probably serve as such, though undesignedly on the part of the Indians.

Magic rites were observed in gathering medicinal materials. This extract from Mooney's Sacred Formulas of the Cherokees describes the practices of that tribe in this respect:

> In searching for his medicinal plants the doctor goes provided with a number of white and red beads, and approaches the plant from a certain direction, going round it from right to left one or four times, reciting certain prayers the while. He then pulls up the plant by the roots and drops one of the beads into the hole and covers it up with the loose earth. * * * the bead is intended as a compensation to the earth for the plant thus torn from her bosom. * * * In some cases the doctor must pass by the first three plants met until he comes to the fourth, which he takes and may then return for the others. The bark is always taken from the east side of the tree, and when the root or branch is used it must also be one which runs out toward the east, the reason given being that these have imbided more medical potency from the rays of the sun.

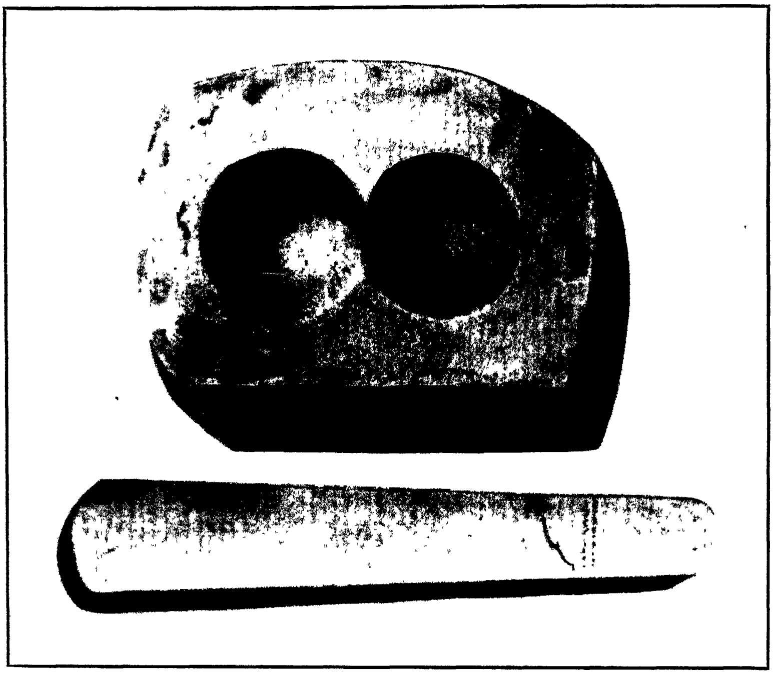

FIG. 15.—INDIAN MORTAR AND PESTLE

Some tribes were very careful in preserving drugs. Articles of materia medica were dried by hanging in lodges. They were then pounded in a mortar (fig. 15), and tied up in bags of animal tissue, such as the coat of a bladder impervious to air, and, to a certain extent, to water.

The following are a few of the Indian drugs exhibited in the National Museum's collection, in most instances to call attention to the methods of treatment rather than to the drugs themselves.

The seeds of *Sophora speciosa*, a shrub or small tree growing in Texas. Contains a poisonous alkaloid. Used as medicine by the Tonkawas. The Indians are said to have used these seeds occasionally as an intoxicant, half a bean producing delirious exhilaration followed by a long period of sleep. Cat. No. 53436, U.S.N.M.

*Sage brush.*—A hot decoction of this herb is used by the Araphoe Indians in fever, and by the Shoshones in venereal diseases. Cat. No. 53533, U.S.N.M.

*Small white sage.*—A species of *Bigelovia.* Used by the Shoshone Indians in the form of hot decoctions. Cat. No. 53534, U.S.N.M.

*Gum weed.*—A species of *Grindelia.* The tops are used in decoction, in venereal diseases, to be drunk freely, either hot or cold. The Araphoe Indians hang it on the tipi poles to ward off lightning. Cat. No. 53536, U.S.N.M.

*Globe flower.*—The root bark and small roots of *Cephalanthus occidentalis*, button bush. A Cherokee Indian remedy for cough, which has been adopted into the domestic medicine of the whites. Cat. No. 53539, U.S.N.M.

*Brazilian tea.*—Used as an adulterant and substitute for Chinese tea, and in the ceremonies of the Indian sorcerers. Cat. No. 53548, U.S.N.M.

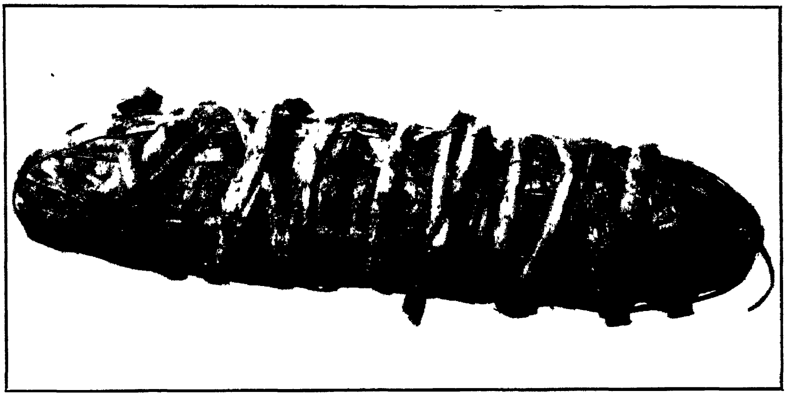

FIG. 16.—WILD-CHERRY BARK

*Large white sage.*—The stems and flowers of a species of *Bigelovia.* The Araphoes rub it between the hands and smell of it, to keep them awake when on the warpath. They also fumigate the tipi with it in sickness. Cat. No. 55535, U.S.N.M.

The stems and flowers of a species of *Dalea*, growing in New Mexico. A cold infusion is used as an emetic, and for bathing the body to increase strength. The plant is named for a bird, the blossoms having the color of the plumage and the stems the strength of the bird. Cat. No. 142207, U.S.N.M.

The dried flowering tops of a species of *Aplopappus.* Used in form of an infusion, one ounce to one quart of water, both internally and as a lotion. Administered for snake bite, in which case the patient must remain alone during four days; should a woman nursing her infant be looked upon, death would follow. Prescribed by medicine men of the Snake order. Cat. No. 142209, U.S.N.M.

*A root used for toothache.*—A piece is made very hot and held between the teeth. Given by medicine men of the Ant order. Although these medicines are often known to others than the doctors, yet the others would not dare collect or use them. Cat. No. 142210, U.S.N.M.

The top and part of the stem of a species of *Aplopappus*, growing in New Mexico. Used in the form of decoction, externally and internally, as a remedy for the irritation of the skin produced by the bites of vermin. Cat. No. 142211, U.S.N.M.

*Star medicine (Psoralea esculenta).*—"Stars falling to the ground penetrating the earth, becoming the tubers of the plant." The farinaceous tubers are used as an article of food. Pounded and mixed with water to the consistency of paste, they are used for poultices. Prescribed by the medicine men of the Snake order. Cat. No. 142212, U.S.N.M.

*Roots.*—Roots of an unknown plant found in New Mexico, growing in lowlands remote from water. Powdered and mixed with water it is given in dysmenorrhea and in protracted labor. Cat. No. 142213, U.S.N.M.

*Aralia root.*—Root of *Aralia nudicaulis*, used in the form of decoction as a remedy for sore eyes. Given by medicine men of the Ant order. No one else is supposed to know the medicine. Cat. No. 142214, U.S.N.M.

*White bead medicine.*—The stems of a species of *Dalea*. A decoction of the plant is used both internally and as a lotion in various diseases. It is emetic in large doses. Cat. No. 142215, U.S.N.M.

*Yellow-rooted grass.*—For toothache. The disease spirit is believed to be a worm which has wrapped itself about the root of the tooth. The doctor invokes in turn a red spider, a blue spider, a black spider, and a white spider, of the Sun Land, to let down threads from above and draw up the intruding worm. After each invocation to a spider follows a prayer to the spirit of fire. The prayers having been said, the doctor blows upon the tooth or outside of the jaw a decoction of the herb. Cat. No. 143092, U.S.N.M.

*Black snakeroot (Aristolochia serpentaria).*—A decoction of the root is blown upon the patient during the ceremonial of exorcism by the medicine man. It is also used for coughs; chewed and spit upon the wound for snake bite; and put in the cavity of a decayed tooth for toothache. Cat. No. 143156, U.S.N.M.

*Crane's-bill (Geranium maculatum).*—A Cherokee remedy. Used in decoctions with frost grape to wash the mouths of infants affected with "thrush." The root of this plant is recognized as an efficient astringent. Cat. No. 143157, U.S.N.M.

*Beggar's-lice.*—The whole plant of a species of *Cynoglossum*. A Cherokee remedy. A decoction of the root or top drunk for kidney disease; the bruised root with bear's oil used as an ointment for cancer. Because of the sticking quality of the burs, a decoction of the plant is taken to aid the memory and in the preparation of love charms. Cat. No. 143158, U.S.N.M.

*Wild-cherry bark.*—For intermittent fever. This disease is believed to be caused by the colonization of malicious insects or worms under the skin. In the preparation of the medicine, the bark is infused in water into which seven coals of fire have been put. The patient is placed with his head toward the rising sun; the doctor, standing in front, with medicine cup in hand, invokes in succession the spirits of the air, of the mountain, of the forest, and of the water; after each invocation he takes some of the liquid in his mouth and blows it on the head, the right shoulder, the left shoulder, and the breast of the patient. The ceremony may be repeated each day for four days (fig. 16). Cat. No. 143160, U.S.N.M.

*Spurge (Euphorbia hypericifolia).*—A Cherokee remedy. The juice is used as a purgative; rubbed on the heads of children for skin eruptions; made into an ointment for sores. Cat. No. 143162, U.S.N.M.

*Galega virginiana.*—"They (the roots) are tough." Common names: Catgut, turkey pea, goat's rue, devil's shoestrings. A Cherokee remedy. Women wash their hair in a decoction of the roots to prevent its breaking or falling out, because these roots are very tough and hard to break; from the same idea ball players rub the decoction on their limbs, after scarification. Cat. No. 143163, U.S.N.M.

*Senega* (*Snakeroot*).—The roots of *Polygala senega*. Used by the Seneca Indians as a remedy for the bite of the rattlesnake. Introduced into medicine of the whites as a stimulating expectorant and diuretic, useful in pneumonia, asthma, and other pulmonary affections. Cat. No. 50389, U.S.N.M.

*Yellow root.*—To hasten childbirth. The doctor, standing by the patient, repeats certain phrases to the effect that a horrible old man or woman is coming for the purpose of hurting the child. He then takes some of a decoction of yellow root in his mouth, and blows it upon the top of the woman's head, upon the breast, and upon the palm of each hand. Cat. No. 50525, U.S.N.M.

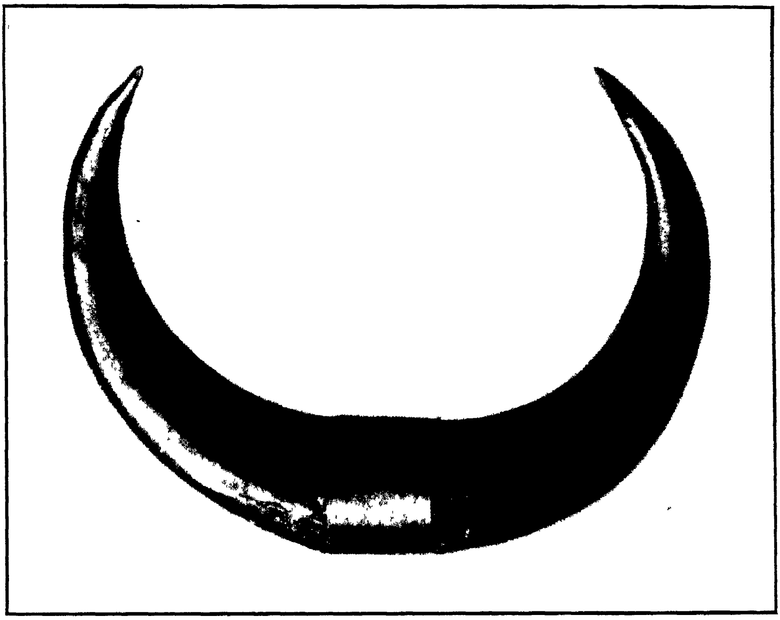

FIG. 17—HORNS

## SURGICAL MEDICINE

The Indians' knowledge of anatomy was, in a great measure, comparative, having been derived from an acquaintance with the structure of the higher order of animals killed in the chase and used as food. Their skill in curing wounds consisted chiefly of close attention to the injured part, and the frequent application of washes which kept the wound clean. Some dexterity was shown in the treatment of fractures and superficial wounds, and the mechanical means of curing consisted of bandaging, bonesetting, cauterizing, counterirritation, cupping (by sucking), cutting, poulticing, scarifying, and venesection. Splints were made of reeds or the bark of trees and fastened to broken bones with bandages in order to prevent motion of the fragments; also in a great degree the contraction of the muscles and consequent shortening of the limb. Hemorrhages were treated with applications of drying powder of vegetable origin. This powder was pressed into a wound and retained with a bandage. Incised wounds were closed with sutures made of the inner bark of certain trees, or the long tendon of the deer, which was removed after several days.

A sudatory (sweat) bath was taken medicinally, and also as a preparation for certain ceremonial observances. Figure 18 is an illustration of this bath. The tent is made with a bent pole covered with blankets or skins. In the illustration the blanket is removed from the front to show the interior. The patient is seated inside upon the ground, with a jug of water by his side, while an assistant is heating stones at a fire outside the tent. The assistant passes the hot stones to the bather, who fills his mouth with water from the jug and blows it upon the stones, where it is instantly converted into vapor which fills the tent and speedily induces perspiration. While in this sweating stage it is customary for the bather to plunge into a pool of cool water, if one is near.

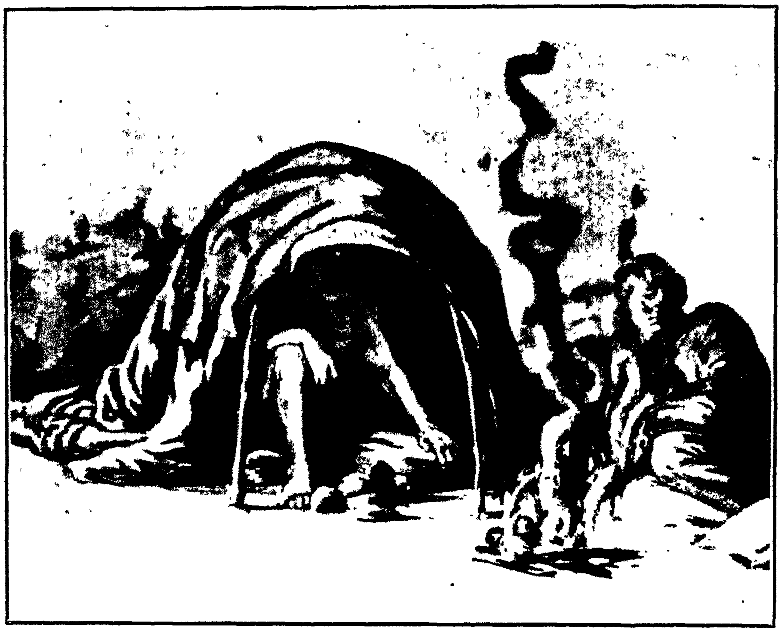

FIG. 18.—SUDATORY (SWEAT) BATH

Venesection was resorted to in the treatment of certain diseases and was performed by the aid of a piece of flint, which was driven into a vein.

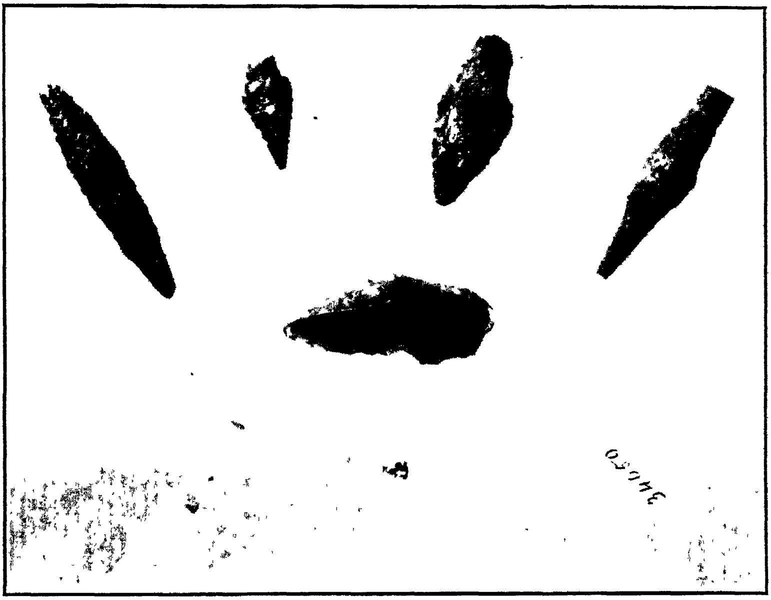

FIG. 19.—LANCETS AND SCARIFICATOR

*Stone lancets.*—Thin chips of flint, about one and one-half inches long and one-quarter inch wide, used for surgical operations (fig. 19). Cat. No. 34050, U.S.N.M.

*Stone lancets.*—Small flint arrowheads used by the Indians for bloodletting (fig. 19). Cat. No. 127758, U.S.N.M.

*Scarificator.*—A small flake of flint. Used for making shallow incisions in the skin for the purpose of drawing blood, and as a preliminary to the applica-

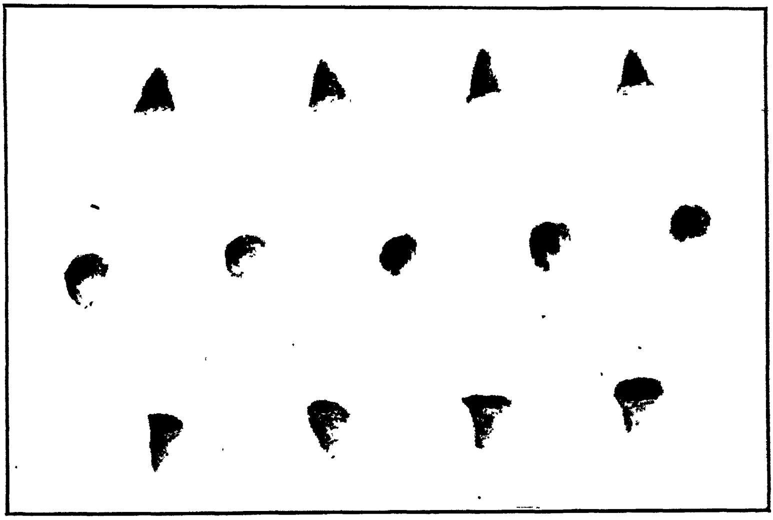

FIG. 20.—MOXA

tion of medicine to strengthen the muscles preparatory to ball games. The scratches were usually made in certain set figures (fig. 19). Cat. No. 141166, U.S.N.M.

Cupping, or local bleeding, was performed after scarification with a piece of flint. A horn, cleaned and perforated at the tip, was used for this purpose. The mouth was applied to the hole in the tip of the horn and a vacuum formed by suction. The Indians cupped very satisfactorily with this simple contrivance, and this remedy was resorted to for acute pain in almost any part to which the horn could be applied. Whatever benefit there may have been from cupping, the Indians probably thought its virtue consisted in the fact that a malevolent spirit or foreign body was thereby drawn out.

*Moxa.*—A form of cautery usually consisting of combustible vegetable fiber which is burned in contact with the skin as a counterirritant. The specimens pictured in figure 20 were made by the Klamath Indians. Cat. No. 141441, U.S.N.M.

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# A SYNOPTIC REVIEW OF THE BEETLES OF THE TRIBE OSORIINI FROM THE WESTERN HEMISPHERE.

By Howard Notman.
*Of Brooklyn, New York.*

The Osoriini of Erichson and the Osoriides of Lacordaire both contain but two genera, *Holotrochus* and *Osorius* distinguished by the presence or absence of spines on the outer edges of the tibiae. Since the publication of the Genera des Coléoptères (1854) many new genera and species have been added to the group. In Part 29 of the Coleopterorum Catalogus of Junk and Schenkling published in 1911 the genera number 11. At the beginning of 1923 the genera number 13 and 121 described species are referred to the genus *Osorius*—65 from the Eastern and 56 from the Western Hemisphere. The author has felt obliged to add to this number. The present paper contains descriptions of 2 new genera and 17 new species, 15 of the latter are referred to *Osorius.*

In spite of the large number of species described, little or nothing has been published concerning the systematics of that genus which makes the task of consulting the scattered descriptions a laborious one. In the Biologia Centrali-Americana,[1] Sharp separates two groups, one of 7 and the other of 8 species, by the form of the thoracic margin. Fauvel gives a table for the separation of 5 species described from New Guinea, based on the sculpture of the head.[2]

It is hoped that the present review may suggest lines for future investigations and assist those wishing to consult the published descriptions.

It is well to call the reader's attention to the fact that the original tribe Osoriini containing *Holotrochus* and *Osorius* included only species having the tarsi 5-jointed,′ whereas the present tribe contains genera in which the tarsi are 3- and 4-jointed, bringing it into closer relationship with the Oxytelini. It may eventually prove advisable to divide the tribe on the tarsal structure.

The material for this study consists of 123 specimens from the collection of the United States National Museum loaned to the writer through the kindness of Dr. E. A. Schwarz and specimens in the collection of the American Museum of Natural History through the kindness of Dr. F. E. Lutz. Unless otherwise stated the type material is in the collection of the United States National Museum.

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[1] Vol. 1, pt. 2, p. 670.

[2] Ann. Mus. Genova, vol. 12, 1878, p. 210.

The following synopsis of genera is based in large part on the original descriptions only. Such genera as could not be identified in the material at hand are marked with an asterisk.

### KEY TO THE GENERA OF THE OSORIINI

1. Elytra without side margins; epipleurae not distinct. Sides of the thorax toothed. Tibia without spines_________________* **Thoracoprius Bernhauer.**[3]
   Elytra with side margins and distinct epipleurae____________________ 2
2. Antennae not geniculate________________________________________ 3
   Antennae geniculate___________________________________________ 7
3. Tarsi 5-jointed______________________________________________ 4
   Tarsi 3-jointed______________________________________________ 6
4. Scutellum absent. Eyes absent. Last joint of the maxillary palpi obtusely subulate______________________________________**Cylindropsis Fauvel.**
   Scutellum present____________________________________________ 5
5. Last tarsal joint somewhat inflated. Last joint of the maxillary palpi conical, twice as long as the preceding_____________**Mimogonus Fauvel.**
   Last tarsal joint normal. Last joint of the maxillary palpi subulate. * **Paragonus Fauvel.**
6. Eyes prominent. Head, thorax, and elytra not sulcate laterally. Tibia not dilated nor spinose_____________________________* **Parosorius Bernhauer.**
   Eyes invisible from above. Head, thorax, and elytra sulcate laterally. Thorax transversely sulcate medially. Tibiae not dilated nor spinose. * **Teiros Eichelbaum.**
7. Tarsi with less than 5 joints_____________________________________ 8
   Tarsi 5-jointed______________________________________________ 11
8. Eyes absent. Tarsi 3-jointed. Elytra obtusely margined. **Ouloglene, new genus.**
   Eyes present________________________________________________ 9
9. Anterior tibiae not dentate nor emarginate, not dilated. Tarsi 3-jointed. **Oryssomma, new genus.**
   Anterior tibiae strongly dentate or emarginate_____________________ 10
10. Anterior tibiae strongly dentate. Tarsi 3-jointed__* **Oephronistus Blackburn.**
    Anterior tibiae dilated, with a deep, semicircular emargination limited by strong processes; spinose apically and basally. Tarsi 4-jointed. ***Atopocnemius Bernhauer.**[4]
11. Tibiae without or with few spines________________________________ 12
    Tibiae multispinose___________________________________________ 14
12. Head without prominent marginal carinae. Eyes wholly visible from above. Tibiae not dilated and without spines___________**Holotrochus Erichson.**
    Head with prominent marginal carinae, partly or wholly concealing the the eyes from above_____________________________________________ 13
13. Thorax with the sides dilated and crenulate. Maxillary palpi with the last joint elongate conic, more than 3 times the length of the preceding joint. Anterior and intermediate tibiae with some spines on the apical half. * **Craspedus Bernhauer.**

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[3] Verh. zool. bot. ges. Wien. vol. 34, 1914, pp. 76–109.
[4] Idem, pp. 70–109.

Thorax very broad and depressed, not crenulate, but with the sides longitudinally carinate and excavate. Anterior tibiae without spines.
* **Mesotrochus** Wasmann.

14. Head and thorax densely alutaceous and opaque; pubescence very dense and short. Thorax without a side margin____* **Anoncosorius** Bernhauer.
Head and thorax always more or less strongly shining. Thorax with a side margin (except in *O. rugipennis* Bernhauer)______**Osorius** Latreille.

### Genus MIMOGONUS Fauvel

*Osorius fauveli* Cameron is stated by its author to be *Mimogonus fumator* Fauvel.[5] A number of specimens in the material at hand agree with the description of this species. These specimens come from. Cordoba, Vera Cruz, Mexico, collected April 10, 11, 18, 23, 1908, and May 4, 1908, by Dr. A. Fenyes.

The two genera described as new in this paper differ from typical *Osorius* as exemplified in *Osorius latipes* Gravenhorst by the absence of a median tubercular swelling on the prosternum. This tuberculation is present in all the species known to me from specimens. *Oryssomma* and *Mimogonus* also differ from *Osorius* in the approximation of the eye and the antenna and in the stout and parallel first antennal joint.

### OULOGLENE, new genus

*Genotype.—Ouloglene barberi*, new species.

Maxillary palpi 4-jointed, first joint small, second much larger and inflated, third small, about half the length of the second; fourth elongate conic, three times the length of the third, obtuse at apex.

Labial palpi 3-jointed, first joint small, second and third elongate, not differing much in length and thickness.

Ligula broad and truncate at apex.

Mentum with the apex circularly rounded and submarginally excavate. Mandibles prominent.

Eyes absent. The antennal furrow with its posterior margin somewhat thickened and pigmented. Clypeus margined. Labrum entire, with a marginal series of numerous coarse bristles.

Antennae rather short, with a distinct 5-jointed club; first joint long and thicker, strongly bent at base, distinctly clavate, second joint elongate and thicker.

Pro- and mesosterna rather long. All the coxae subcontiguous.

Thorax acutely, elytra rather obtusely margined, Scutellum present.

Anterior tibiae somewhat dilated; all the tibiae more or less coarsely spirose. Tarsi 3-jointed, the last joint longer than the preceding two taken together.

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[5] Cameron, Ann. Mag. Nat. Hist., vol. 11, p. 398 (1923). *Osorius fauveli* was described from Haiti Ans. Mag. Nat. Hist., vol. 12 (1923), p. 326.

### OULOGLENE BARBERI, new species

Form elongate, slender, cylindrical. Color uniform testaceous. Integuments smooth and shining, subimpunctate, a few setiferous punctures on the posterior abdominal segments above and beneath. Head large, as wide as the thorax at apex, as wide as long. Antennae reaching the middle of the thorax; second joint as long as the next three and much thicker, third joint slightly elongate, fourth, fifth, and sixth small, subglobular, seventh to tenth increasing in size, about one-third wider than long, last joint conical, about as long as the preceding two. Thorax as wide as long, widest at the apical margin; sides gradually narrowed to behind the middle, thence strongly rounded to the base; posterior angles not distinct, anterior angles subrectangular, scarcely rounded; side-margins very fine; a distinct, rounded impression either side at the base. Elytra conjointly one-half wider than long, four-fifths the length of the thorax; sides parallel, suture margined and impressed, surface with indistinct impressions. Abdomen gradually wider to the fifth segment where it is distinctly the widest part of the body. Length 2 mm., width 4 mm. One specimen.

*Type-locality.*—Cacao, Trece Aguas, Alta V. Paz, Guatemala, April 18, 1906. (Schwarz and Barber, collectors).

*Type.*—Cat. No. 26349, U.S.N.M.

### ORYSSOMMA, new genus

*Genotype.*—*Oryssomma schwarzi*, new species.

Maxillary palpi 4-jointed, first joint small, second and third large, equal in size and not elongate, fourth much longer but scarcely larger, longer than the preceding joints together, acuminate at apex.

Labial palpi 3-jointed, basal joints short, terminal joint much longer, joints not differing much in thickness.

Ligula broad and truncate at apex.

Mentum with the apex broadly truncate and submarginally excavate. Mandibles prominent. Eyes small, feebly convex. Labrum broadly and distinctly emarginate, with long, coarse bristles scattered over the disk.

Antennae geniculate, rather short, gradually incrassate distally; first joint longer and thicker, straight, not clavate, second joint elongate, longer but not much thicker than the following.

Pro- and mesosterna long. All the coxae contiguous. Mesosternum and first ventral segment with median carinae.

Thorax and elytra acutely margined. Scutellum present.

Tibiae not dilated, with few spines. Tarsi 3-jointed, last joint longer than the preceding together. Basal joint of the posterior tarsi elongate, twice as long as the second.

### ORYSSOMMA SCHWARZI, new species

Form somewhat robust, cylindrical. Color rufo-testaceous; head, apices of the elytra and the fourth and fifth abdominal segments darker, piceous. Integuments above smooth and strongly shining; head with sparse umbilicate setiferous punctures, thorax with a few coarse umbilicate punctures bearing long bristles and more numerous fine punctures with short hairs; head beneath and laterally behind the eyes and the sterna distinctly and rather coarsely reticulate; abdomen coarsely reticulate, with rather long, sparse pubescence, mixed with finer and denser pubescence. Head large, slightly transverse, scarcely narrower than the thorax at apex. Antennae reaching the middle of the thorax, second joint as long as the next two and a little thicker, third joint one-half longer than wide and nearly twice as long as the fourth, fourth subglobular, succeeding joints gradually larger, not transverse, terminal joint scarcely as long as the preceding two. Thorax slightly transverse, sides narrowing and feebly arcuate from near the anterior angles to the base, angles all distinct but somewhat rounded and obtuse; side margins very fine, a feeble, rounded impression in the posterior angles. Elytra conjointly slightly longer than wide, as wide as the thorax and one-fifth longer; sides parallel, suture margined and rather broadly impressed. Abdomen parallel, not wider than the thorax. Length 1.75 mm., width .4 mm. One specimen.

*Type locality.*—Cacao, Trece Aguas, Alta V. Paz, Guatemala, April 18, 1906. (Schwarz and Barber, collectors).

*Type.*—Cat. No. 26350, U.S.N.M.

It is interesting to note the difference in the arrangement of the bristles on the labrum in the two last-described genera. In *Oulogene* they are in a marginal row whereas in *Oryssomma* they are scattered over the disk.

### Genus OSORIUS Latreille

The following synopsis has been prepared by an examination of the specimens available and supplemented by a study of the original descriptions. The key contains all the species known to occur in the Americas, but inasmuch as no additional information could be added concerning many of the species, it has not been considered advisable to discuss these farther on in the text. The species known only from the original descriptions are marked with an asterisk. After the key there are descriptions of the new forms and a list of the species available with their distribution based on the material before me. Following this is an alphabetical list of the species of *Osorius* described from North and South America.

### KEY TO THE AMERICAN SPECIES OF OSORIUS LATREILLE

1. Thorax wider posteriorly. The labrum asymmetrical. Length 12–15 mm. *** asymmetricus** Fauvel.
   Thorax not wider posteriorly. The labrum not asymmetrical-------- 2
2. Body very densely and conspicuously pubescent. The thorax longer than wide. Length 8 mm-------- *** hirtulus** Fauvel.
   Body not conspicuously pubescent-------- 3
3. Thorax without a side margin. Head very densely and strongly punctate. The elytra rugulose. Length 4.5–5 mm-------- *** rugipennis** Bernhauer.
   Thorax with a side margin-------- 4
4. Anterior angles of the clypeus conspicuously produced-------- 5
   Anterior angles of the clypeus not conspicuously produced-------- 7
5. Head alutaceous and subopaque anteriorly, with a definitely marked posterior, highly polished area. The thorax rather densely and finely punctate, somewhat broader than long. Length 6.5 mm-- *** dentatus** Bernhauer.
   Head without a sharply defined, posterior, highly polished area-------- 6
6. Thorax more coarsely and densely punctate. The abdominal segments with distinct and rather dense punctuation on the lateral declivity. Length 9.5 mm-------- **hubbardi**, new species
   Thorax more finely and sparsely punctate. The abdominal segments without punctuation on the lateral declivity. Length 12–14 mm---- **ater** Perty.
7. Thorax distinctly longer than broad. The head, thorax, elytra and abdomen strongly and rather densely punctured. Length 3.5 mm. **eggersi** Bernhauer.
   Thorax not distinctly longer than broad-------- 8
8. Thorax with the lateral margins fine throughout-------- 9
   Thorax with the lateral margins broader and more strongly reflexed posteriorly-------- 42
9. Dorsal segments of the abdomen more or less densely and conspicuously punctured-------- 10
   Dorsal segments of the abdomen more or less sparsely punctured-------- 32
10. Clypeus strongly emarginate-------- **politus** LeConte.
    Clypeus truncate or subtruncate-------- 11
11. Head distinctly narrower than the thorax. The thorax rather finely punctate. The sides parallel to behind the middle, with the anterior angles prominent. Abdomen without a median smooth stripe. Length 6 mm-------- **parviceps**, new species.
    Head not narrower than the thorax-------- 12
12. Head scabro-rugulose laterally in front of the eyes. The thorax with base and apex nearly equal, scarcely broader than long. The elytra indistinctly punctate. The abdomen with a median smooth stripe. Length 5–6 mm-------- *** frater** Lynch.
    Head not scabro-rugulose in front of the eyes-------- 13
13. Front of the head more distinctly alutaceous anteriorly-------- 14
    Front of the head not distinctly alutaceous though sometimes coarsely and closely punctured-------- 22
14. Elytra strongly rugose. Length 5.5 mm-------- *** argentinus** Bernhauer.
    Elytra more or less sparsely and indistinctly punctate-------- 15
15. Size larger. Form broader. Posterior angles of the thorax less obtuse. Length 8–9 mm-------- *** crassus** Sharp.
    Size smaller. From narrower, not more than 7 mm-------- 16

16. Thorax as long as broad, with the base scarcely perceptibly narrower than the apex and the sides scarcely arcuate. Length 7 mm.
**breviceps**, new species.
Thorax with the base distinctly narrower than the apex_____________17

17. The thorax and elytra distinctly alutaceous. The thorax as broad as long, the sides not sinuate before the posterior angles and feebly narrowed posteriorly. The elytra as broad as long. Length, 5.5–6 mm.
**schwarzi**, new species.
Thorax and elytra not alutaceous_____________ 18

18. Third antennal joint short sub-globular. Size smaller. Length 4.5 mm.
**minor**, new species.
Third antennal joint distinctly elongate_____________ 19

19. Thorax narrower, slightly longer than broad, sides not sinuate before the posterior angles. The elytra longer than broad. Length 4 mm.
**salvini** Sharp.
Thorax broader _____________ 20

20. Thorax with sides distinctly sinuate before the posterior angles, rather evenly and strongly convergent posteriorly. The elytra scarcely as long as broad. Length 5–6.75 mm._____________**brevipennis**, new species.
Thorax with the sides not sinuate before the posterior angles_________ 21

21. Thorax with the sides more parallel anteriorly and rather strongly and suddenly narrowed near the base; slightly transverse, not wider than the elytra. Length 5.5–7 mm_____________**parcus** Sharp
Thorax with the sides more evenly and strongly convergent posteriorly, distinctly wider than the elytra_____________**planifrons** LeConte.

22. Head coarsely and densely punctured, with a narrow median smooth stripe or fulsiform area_____________ 23
Head more or less sparsely punctured; median smooth stripe wider and more indefinite _____________ 27

23. Abdomen densely and coarsely granulate-punctate. The elytra more strongly and densely punctured. The thorax distinctly narrowed posteriorly. Larger. Length 5 mm_____________* **cordovensis** Bernhauer.
Abdomen not granulate-punctate. The elytra less distinctly punctate. Smaller. Length 3.5 mm. or less_____________ 24

24. Median smooth stripe of the thorax broader_____________ 25
Median smooth stripe of the thorax very narrow and subcarinate or subobsolete _____________ 26

25. Thorax as wide as the elytra and equal in length, very little narrowed posteriorly. Length 3.5 mm_____________**micros** Sharp.
Thorax wider than the elytra and slightly longer, more narrowed posteriorly and more strongly rounded basally. Length 3.5 mm.
**laeviceps**, new species.

26. Median smooth stripe of the thorax subcarinate. The punctuation coarse and dense. The thorax less narrowed posteriorly. Length 3 mm.
**carinicollis**, new species.
Median smooth stripe subobsolete. The thorax more narrowed posteriorly, with the punctures finer and less dense. Length 2.5 mm.
**exiguus**, new species.

27. Thorax coarsely and closely punctured, with a very definite median smooth stripe. The elytra coarsely and moderately closely and deeply punctured, longer than the thorax. The abdomen above densely, asperately puncture, and opaque. The eyes larger and more prominent. The thorax more narrowed basally. Length 6 mm_____________* **oculatus** Sharp.
Thorax sparsely punctured, with the smooth stripe less definite_________ 28

28. Thorax with the median smooth stripe indistinct. The elytra longer than broad, slightly longer than the thorax. Length 7.5 mm----**mundus** Sharp.

Thorax with the median smooth stripe distinctly limited either side by a row of puctures---------------------------------------- 29

29. Outer antennal joints not transverse. The thoracic and elytral punctures in general coarser and more numerous. Length 5–5.5 mm. **latipes** Gravenhorst.

Outer antennal joints distinctly transverse. The thoracic and elytral punctures in general sparser and finer---------------------------------------- 30

30. Punctures of the fifth dorsal abdominal segment larger, variolate. The elytra frequently with a distinct discal row of punctures. Larger. Length 5–5.5 mm----------------------------**variolatus**, new species.

Punctures of the fifth dorsal abdominal segment smaller, not variolate. Smaller. Length 4,5 mm. or less---------------------------------------- 31

31. Thorax slightly wider than the elytra, with the sides more strongly narrowed posteriorly. Larger. Length 4.5 mm------**difficilis**, new species.

Thorax not wider than the elytra. The sides less narrowed posteriorly. Smaller. Length 3.5–4 mm------------------------**brevicornis** Notman.

32. Thorax distinctly broader than long. The head with the vertex strongly shining. The clypeal angles prominent. Length 7 mm. * **sublaevis** Bernhauer.

Thorax about as broad as long---------------------------------------- 33

33. Clypeus emarginate, with the anterior angles more or less distinctly prominent---------------------------------------- 34

Clypeus truncate or subtruncate---------------------------------------- 37

34. Median smooth stripe of the thorax not bounded by seriate punctures. Length 7 mm----------------------------------------* **germanus** Sharp.

Thorax with seriate punctures or more or less coarsely and closely punctured---------------------------------------- 35

35. Elytra subimpunctate. Smaller. Lenght 5 mm----* **mexicanus** Bernhauer.

Elytra punctate---------------------------------------- 36

36. Front of the head longitudinally rugulose between the eyes. The elytra with a few subseriate punctures. Length 8.5 mm--* **cylindricus** Latreille.

Front of the head not rugulose, punctate with a smooth space before the vertex. The elytra coarsely and strongly punctured. Length 10 mm. * **solidus** Sharp.

37. Thorax without seriate punctuation. The median smooth stripe indistinct. 38

Thorax with distinct seriate punctuation or with the smooth stripe well defined---------------------------------------- 39

38. Head, thorax, and elytra with coarse punctuation. The head and thorax distinctly alutaceous; the elytra shining. The thorax with the sides sinuate before the posterior angles. Length 9 mm------***affinis** Sharp.

Head, thorax, and elytra not distinctly alutaceous, finely, the thorax and elytra very sparsely punctate. The head narrower than the thorax. The elytra longer than the thorax. Length 4.5 mm. * **laeviusculus** Bernhauer.

39. Thoracic punctuation fine and sparse; the dorsal series composed of six rather fine punctures. Length 7 mm---------* **sexpunctatus** Bernhauer.

Thoracic punctuation coarse or with dorsal series of more numerous punctures---------------------------------------- 40

40. Thorax with the sides parallel to behind the middle, thence suddenly narrowed to the obtuse and rounded posterior angles. The head distinctly alutaceous laterally. The elytra distinctly rugose. Length 3.5–5 mm. *** parvulus** Scriba.
Thorax with the sides evenly narrowed throughout____________________41
41. Head distinctly alutaceous, strongly and rather sparsely punctured laterally. The thorax with two rows of strong punctures. The elytra distinctly rugose. Length 5.5 mm____________*** neotropicus** Bernhauer.
Head not alutaceous, shining, rather closely punctate. The elytra sparsely punctate, rather longer than the thorax. The mandibles with a strong tooth. Length 5 mm__________________________________*** debilis** Sharp.
42. Thorax with a distinct, subentire, median canaliculation________________43
Thorax with the canaliculation more or less indistinct and much abbreviated____________________________________________________________44
43. Head not distinctly narrower than the thorax. The abdomen in large part smooth and shining. Length 9 mm________*** laevigatulus** Schubert.
Head distinctly narrower than the thorax. The abdomen densely longitudinally strigose throughout. Length 9.5 mm__*** wasmanni** Bernhauer.
44. Clypeus squarely truncate and crenulate____________________________________45
Clypeus not truncate and crenulate________________________________________47
45. Thorax distinctly transverse. The abdomen impunctate. Length 8 mm. **crenulifrons**, new species.
Thorax scarcely transverse. The abdomen punctate____________________46
46. Elytra with an irregular row of 5 or 6 rather coarse setiferous punctures along the suture. The thorax with strong foveae before the posterior angles. 5th, 6th, and 7th joints of the antennae alongate. Length 11 mm________________________________________________**manni**, new species.
Elytra wholly impunctate. The thoracic foveae much feebler. 5th, 6th, and 7th joints of the antennae globular. Length 4.75–7 mm. **buscki**, new species.
47. Thorax distinctly transverse____________________________________________48
Thorax scarcely or not transverse________________________________________58
48. Clypeus tri-emarginate. The eyes strongly convex. The head finely alutaceous; punctuation obsolete. Length 8 mm______________*** boops** Sharp.
Clypeus not tri-emarginate_______________________________________________49
49. Clypeus simply emarginate. The head very dull and subimpunctate. The elytra subimpunctate. Length 8 mm_______________*** opacifrons** Sharp.
Clypeus more or less distinctly bisinuate and subprominent medially______50
50. Head and thorax not alutaceous, very finely and sparsely punctured, strongly shining. The elytra densely and strongly rugulose. Length 10 mm_________________________________________*** latimargo** Bernhauer.
Head and thorax strongly alutaceous or densely punctured______________51
51. Head strongly alutaceous, with more or less distinct punctures__________52
Head not or scarcely alutaceous, more or less densely or strongly punctured____________________________________________________________56
52. Thorax scarcely alutaceous. The elytra more or less finely and sparsely punctate, shining. The abdomen impunctate__________________________53
Thorax distinctly alutaceous. The elytra strigulose. The apical ventral abdominal segment coarsely strigose. The thorax with the sides sinuate before the posterior angles_____________________________________________54
53. Thorax one-third wider than long. The elytra more distinctly punctured, rugulose. Length 11 mm___________________________**brasiliensis** Guérin. *** peruvianus** Bernhauer.

Thorax one-fourth wider than long. The elytra scarcely punctate, not rugulose. Length 9.5–10 mm ---------- * **sahlbergi** Bernhauer.

54. Thorax not so broad, less narrowed posteriorly; the canaliculation one-half the length of the thorax, strong and rather deeply impressed. Smaller. Length 10 mm ---------- **confusus**, new species.

Thorax broader, more narrowed posteriorly; the canaliculation fine and short. Larger. Length 13.5–22 mm ---------- 55

55. Head and thorax less alutaceous, more strongly and closely punctate. The clypeus less prominent medially. Smaller. Length 13.5–14.5 mm. **alternans** Bernhauer.

Head and thorax more alutaceous; punctuation finer and sparser. The clypeus more prominent medially. Larger. Length 18–22 mm. **stipes** Sharp.

56. Apical ventral segment coarsely rugulose-punctate. The mandibles without teeth. The posterior angles of the thorax slightly prominent. Length 10–12 mm ---------- **canaliculatus** Solsky.

Apical ventral segment with a few coarse punctures. The thorax densely punctate. The elytra sparsely punctate ---------- 57

57. Thorax broader and less narrowed posteriorly. The mandibles with a well-defined tooth. Length 11 mm ---------- **vicinus** Sharp.

Thorax narrower, more strongly narrowed posteriorly. The mandibles without a tooth. Length 12 mm ---------- **puncticeps** Sharp.

58. Clypeus subtruncate. The head distinctly punctate. The thorax extremely finely and sparsely punctate. Length 7.5 mm -- * **laevicollis** Bernhauer.

Clypeus emarginate, with the angles more or less prominent or more or less distinctly bisinuate ---------- 59

59. Head and thorax distinctly punctured ---------- 60

Head and thorax very finely and sparsely or obsoletely punctured ---------- 64

60. Clypeus bisinuate, more or less prominent medially. The thorax slightly transverse ---------- 61

Clypeus emarginate, not prominent medially. The apical ventral segments of the abdomen punctured medially ---------- 62

61. Thorax with the sides not sinuate before the posterior angles; the surface alutaceous; the canaliculation very short and indistinct. The apical ventral segments of the abdomen smooth medially. Length 13 mm. ***nitens** Sharp.

Thorax with the sides distinctly sinuate before the posterior angles; the surface not alutaceous; the canaliculation nearly one-half the length of the thorax, coarse but feebly impressed. The apical ventral segment of the abdomen strongly strigose throughout. Length 10 mm. **morio**, new species.

62. Head dull, alutaceous. Length 10 mm ---------- * **granulatus** Bernhauer.

Head smooth, shining ---------- 63

63. Clypeal angles not prominent. The head more closely punctured. The abdomen sparsely punctured above. Length 12.5 mm --- * **integer** Sharp.

Clypeal angles rather thick and prominent. The head sparingly punctured. The abdomen impunctate above. Length 11.5 mm ----- * **simplex** Sharp.

64. Head slightly narrower than the thorax at apex. The clypeus emarginate ---------- 65

Head as wide as the thorax at apex ---------- 66

65. Thorax with the sides not distinctly sinuate. The abdomen impunctate above, sparsely punctate beneath. The elytra impunctate. Length 9 mm. * **piceus** Erichson.

Thorax with the sides very strongly sinuate. The elytra with few punctures, rather densely aciculate. Length 10.5 mm.
*** sinuaticollis Bernhauer.**

66. Elytra punctate. The head and thorax alutaceous. Lenth 11.5 mm.
*** columbinus Bernhauer.**

Elytra impunctate——————————————————————67

67. Clypeus emarginate——————————————————————68

Clypeus bisinuate——————————————————————69

68. Apical ventral segments of the abdomen moderately closely, evenly punctate. Length 10 mm—————————— **laevigatus Sharp.**

Apical ventral segments of the abdomen more closely punctate medially than laterally. The elytra not rugulose. Length 10 mm.
*** propinquus Bernhauer.**

69. Size larger—15 mm. The elytra with the sutural stria impressed. The abdomen with the 6th ventral segment punctulate, the 7th impunctate. Length 15 mm—————————— **intermedius Erichson.**

Size smaller—10 mm. The thorax with a feeble median canaliculation. The last two ventral segments of the abdomen with rather sparing punctuation. The clypeus rather obsoletely bisinuate. Length 10 mm.
*** dubius Sharp.**

The original description of *Osorius pygmaeus* Cast is too short to admit of the species being placed with any accuracy in the above table without specimens from the type locality. The original description follows:

> Long. 2 lignes. Larg. ½ ligne.—D'un noir brillant, fortement ponctué; parties de la bouche et antennes rougeâtres; corselet allant un peu en s'élargissant en avant, à côtés droits; élytres un peu rougeâtres, surtout latéralement; pattes de même couleur. (Cayenne.) (Etud, ent., vol. 6, 1835, p. 130.)

### OSORIUS HUBBARDI, new species

Form slightly broad; color dark castaneous. Head strongly alutaceous; punctures very fine and sparse, more numerous over the eyes. Thorax very indistinctly alutaceous; punctures moderate in size and sparseness, somewhat elongate laterally. Elytra rather finely rugose and distinctly and sparsely punctate. Abdomen very finely and sparsely punctate dorsally, more distinctly and numerously laterally; beneath more distinctly punctate; apical segment not at all rugose. Head very slightly narrower than the thorax at apex; clypeus with the apical angles produced in long prominent teeth, margin between straight; antennae extending to the anterior one-third of the thorax, scarcely at all incrassate externally, moniliform, the second and third joints elongate, the latter longer; the first as long as the next four. Thorax one-fourth wider than long; sides parallel to the middle, thence moderately convergent and scarcely arcuate to the posterior angles, which are obtuse, slightly sinuate before the angles; anterior angles very minutely denticulate; side margins very slightly expanded basally, where there is a feeble fovea; base and apex finely margined. Elytra as wide as the thorax basally, slightly wider one-third from the apex, very slightly longer than the thorax and scarcely wider than long; suture impressed and margined. Prosternal tuberculation rounded at apex. Length 9.5 mm., width 2.25 m..

*Type locality.*—Jamaica, W. I. (H. G. Hubbard).

*Type.*—Cat. No. 26331, U.S.N.M.

### OSORIUS PARVICEPS, new species

Form slightly broad; color dark piceo-castaneous, thorax and elytra a little paler. Head very indistinctly alutaceous, thorax and elytra not at all. Head sparsely and rather coarsely punctured medially, punctures more numerous and rugose around the eyes, vertex smooth; thorax somewhat coarsely and closely punctured, punctures elongate; a rather narrow median stripe impunctate, bounded by very irregular and indistinct series of punctures on either side; elytral punctures slightly coarser and sparser; abdomen dorsally somewhat less coarsely and rather closely punctured, more sparsely medially, but without a definite smooth stripe; punctures beneath slightly more coarse, the apical segment not at all strigose. Head distinctly narrower than the thorax at apex; clypeus broadly emarginate, angles slightly prominent, bidenticulate; antennae reaching the middle of the thorax, joints seven to eleven distinctly larger, about as long as wide; first joint as long as the next three; second and third slightly elongate, subequal; third more slender. Thorax as wide as long, wider than the elytra, with the sides very slightly convergent to behind the middle, thence rather strongly convergent and moderately arcuate to the posterior angles which are scarcely distinct; anterior angles rather distinctly prominent; side margins fine throughout; base margined, apex unmargined; a feeble impression before the posterior angles. Elytra as long as the thorax, as long as wide; suture scarcely impressed. Prosternal tuberculation rounded at apex. Length 6 mm.. width 1.5 m..

*Type locality.*—Crescent City, Fla. (Hubbard and Schwarz).

*Type.*—Cat. No. 26332, U.S.N.M.

### OSORIUS BREVICEPS, new species

Form, scarcely slender; color dark piceo-castaneous, nearly uniform. Head somewhat indistinctly alutaceous, moderately shining; thorax very indistinctly alutaceous; elytra feebly and irregularly rugulose. Head rather coarsely and moderately densely punctate, rugulose around the eyes; without a median impunctate stripe, vertex smooth and shining; thorax coarsely, moderately densely and somewhat strigose-punctate with a rather narrow median impunctate stripe which is not bounded by seriate punctures; elytra sparsely and very indistinctly punctate; abdomen rather coarsely and densely punctate dorsally, the punctures finer and sparser medially, apical ventral segment rather coarsely and closely granulate and rugulose with a narrow median impunctate stripe which is alutaceous. Head rather small, scarcely narrower than the thorax at apex; clypeus subtruncate, the angles scarcely prominent; antennae reaching the middle of the thorax, joints seven to eleven distinctly larger, moniliform, second and third somewhat elongate, subsequal, the third more slender, the first joint as long as the next three or four. Thorax as long as broad; base very slightly narrower than the apex; sides feebly arcuate; posterior angles narrowly rounded, anterior not at all prominent; side margins very slightly wider posteriorly, base and apex unmargined; posterior angles with feeble elongate impressions. Elytra slightly wider, scarcely longer than the thorax, about as long as wide; suture very slightly impressed. Prosternal tuberculation strong, rounded at apex. Length 7 mm., width 1.5 mm.

*Type locality.*—San Bernardino, Paraguay (K. Fiebig).

*Type.*—Cat. No. 26333, U.S.N.M.

### OSORIUS SCHWARZI, new species

Form scarcely slender; color black, elytra faintly picescent; legs and antennae rufo-piceous. Head, thorax, and elytra distinctly alutaceous. Head indistinctly and sparsely punctured, punctures more numerous and indistinctly rugulose around the eyes; no median impunctate stripe; thorax coarsely, indistinctly and somewhat sparsely punctured, median impunctate stripe not bounded by distinct series; elytra indistinctly and rather sparsely punctate; abdomen rather densely punctured dorsally with a narrow impunctate stripe on the fifth segment, apical segment beneath rather closely punctate but not at all rugose. Head scarcely narrower than the thorax at apex; clypeus broadly emarginate, angles slightly prominent and bidenticulate; antennae reaching the middle of the thorax, joints seven to eleven distinctly larger, scarcely transverse, subobconic, second and third joints elongate and subequal, about three-fourths longer than wide, the third slightly more slender, first joint as long as the next three. Thorax as broad as long or scarcely transverse, base slightly narrower than the apex, sides feebly arcuate, posterior angles minutely subprominent; side margins fine throughout, apex unmargined, base indistinctly margined; basal impressions feeble. Elytra as wide as the thorax, as wide as long; suture distinctly impressed. Prosternal tuberculation rounded at apex. Length 5.5–6 mm., width 1.25 mm.

*Type locality.*—Cayamas, Cuba 20.5 (E. A. Schwarz); 3 Paratypes, Cayamas, Cuba, 11.5; 20.5; 30.5 (E. A. Schwarz). 1 Paratype, Cayamas, Cuba, 20.5 (E. A. Schwarz), in the writer's collection.

*Type.*—Cat. No. 26334, U.S.N.M.

### OSORIUS MINOR, new species

Form somewhat robust. Color piceous black; legs and antennae pale rufo-testaceous. Head distinctly alutaceous in front; thorax and elytra not alutaceous, shining. Head rather distinctly but sparsely punctured; median impunctate stripe not distinct. Thorax coarsely, deeply, and somewhat sparsely punctured; median smooth stripe bounded by distinct series of punctures. Elytra with three rather distinct discal series of punctures. Abdomen coarsely, uniformly, and rather densely punctured above; apical ventral segment sparsely and somewhat finely punctured. Head not narrower than the thorax. Clypeus subtruncate with the apical angles denticulate. Antennae exceeding the middle of the thorax; joints seven to ten slightly transverse, four to six globular, third very short, subglobular, second about twice as long as wide. Thorax scarcely as broad as long; base distinctly narrower than the apex with the sides evenly and feebly arcuate. Posterior angles rounded and obtuse, scarcely distinct; anterior angles minutely prominent. Side margins fine throughout; base feebly margined; apex unmargined; basal impressions obsolete. Elytra just perceptibly wider than the thorax; conjointly slightly wider than long. Sides slightly divergent posteriorly; suture rather strongly impressed. Prosternal tuberculation rounded at apex. Length 4.5 mm., width 1.25 mm.

*Type-locality.*—Montserrat, Trinidad, West Indies. June 30, 1905 (Aug. Busck).

*Type.*—Cat. No. 27330, U.S.N.M.

### OSORIUS BREVIPENNIS, new species

Form slightly broad; color black, thorax picescent, elytra, antennae, and legs rufo-piceous. Head alutaceous anteriorly, smooth and shining on the vertex; thorax very indistinctly alutaceous laterally, elytra not at all alutaceous but finely and indistinctly rugulose; abdomen more or less alutaceous, particularly the fifth segment. Head coarsely and rather densely punctate with a median impunctate stripe, feebly rugulose over the eyes; thorax coarsely and somewhat closely punctate, the punctures elongate and distinctly seriate either side of the median impunctate stripe; elytral punctures coarse, sparse, subseriate; abdomen rather densely punctate dorsally with a narrow median impuncate stripe, the apical ventral segment somewhat sparsely punctate and not at all rugose. Head scarcely wider than the thorax at apex; clypeus subtruncate, angles scarcely at all prominent; antennae reaching the middle of the thorax, joints seven to eleven distinctly larger, as long as wide, scarcely obconic; second and third elongate, one-third longer than wide; the third more slender; the first as long as the next three. Thorax as long as wide, slightly wider than the elytra; base narrower than the apex; sides rather strongly arcuate and slightly sinuate before the posterior angles which are obtuse, scarcely distinct, anterior angles definite but not prominent; side margins very fine throughout, apex unmargined, base margined, basal impressions not distinct. Elytra scarcely shorter than the thorax, scarcely transverse; suture distinctly impressed. Prosternal tuberculation rounded and rather broad at apex. Length 5–6.5 mm., width 1.25–1.5 mm.

*Type* and *paratype localities*.—Type and 4 paratypes, Fort Grant, Ariz., 12, VII (Hubbard and Schwarz). 3 paratypes, Santa Rita Mountains, Ariz., 20, V; 11, VI; 14, VI (Hubbard and Schwarz). 1 paratype, Colima, Col. Mex. (Conradt). 1 paratype, Chietla, Pueblo, Mex. 2 paratypes Matamoras, Puebla, Mex. 1 paratype, Mexico. 1 paratype, Cacao Trece Aguas, Alta V. Paz Guatemala, Apr. 18, 1906 (Barber and Schwarz).

*Type*.—Cat. No. 26335, U.S.N.M.

1 paratype, Fort Grant, Ariz., 1, VII (Hubbard and Schwarz), in the writer's collection.

### OSORIUS LAEVICEPS, new species

Form rather slender. Color dark ferruginous. Integuments throughout smooth, shining, not at all alutaceous. Head with rather coarse and moderately dense punctures, an impunctate area on the vertex. Thorax coarsely and somewhat densely punctured, with a definite smooth, median stripe bounded by series of impressed punctures. Elytra coarsely, evenly, and somewhat densely punctured. Abdomen similarly punctured and without a median, smooth stripe. Head as wide as the thorax at apex, as long as wide. Antennae reaching the middle of the thorax; second joint one-half longer than wide and slightly thicker; third joint slightly elongate; fourth to sixth subglobular; seventh to eleventh abruptly larger; ninth and tenth distinctly transverse. Thorax as wide as long, strongly narrowed behind the middle, posterior angles very obtuse, anterior angles minutely subdenticulate, side margins very fine throughout. Elytra slightly narrower and slightly shorter than the thorax, conjointly as long as wide, the suture impressed and margined. Abdomen at the fifth segment slightly the widest part of the body. Length 3.5 mm., width .75 mm. One specimen.

*Type-locality*.—San Juan, Porto Rico, July 1–5, 1915. (Lutz and Mutchler, sifting.)

*Type*.—In the collection of the American Museum of Natural History.

### OSORIUS CARINICOLLIS, new species

Form somewhat slender; color dark castaneous, uniform. Above not at all alutaceous. Head coarsely and closely punctate, punctures sparser in front, a narrow median impunctate stripe; thorax coarsely and closely punctate, median impunctate stripe narrow and subcariniform. Elytra coarsely, closely, and somewhat rugosely punctate; abdomen rather coarsely and closely punctate above and beneath, median dorsal impunctate stripe not distinct; apical ventral segment rather feebly rugose-punctate. Head as broad as the thorax at apex; eyes rather large but not convex; clypeus truncate; antennae longer, extending to the posterior two-thirds of the thorax; joints 7 to 11 distinctly larger; 8 to 10 slightly transverse; second joint elongate, twice the length of the third and stouter; third as wide as long. Thorax as wide as long, as wide as the elytra; base slightly narrower than the apex, sides feebly arcuate, more strongly near the base, not at all sinuate; posterior angles rounded, not distinct, anterior angles definite but not at all prominent; side margins fine throughout, apex not margined, base indistinctly so. Elytra about one-third longer than the thorax, nearly a third longer than wide; suture scarcely impressed. Prosternal tuberculation broad, rounded. Length 3 mm., width .75 mm.

*Type locality*.—25.3 Cacao Trece Aguas, Alta V, Paz Guatemala (Barber and Schwarz.)

*Type*.—Cat. No. 26336, U.S.N.M.

### OSORIUS EXIGUUS, new species

Form rather slender; color brownish testaceous (immature?). Integuments above scarcely alutaceous. Head coarsely and rather closely, uniformly punctate, without median impunctate stripe; thorax rather coarsely, closely and indistinctly punctate, median impunctate stripe very narrow, scarcely distinct; elytra moderately coarsely and closely and indistinctly punctate; abdomen closely punctate dorsally, without median impunctate stripe, apical ventral segment coarsely and indistinctly punctate. Head scarcely wider than the thorax at apex; clypeus truncate; antennae rather short, not reaching the middle of the thorax, joints seven to eleven distinctly larger; five to ten slightly transverse; second joint elongate, stouter, and a half longer than the third, which is not elongate; first joint as long as the next three or four. Thorax as long as broad, as wide as the elytra; sides subparallel, scarcely convergent to behind the middle, thence moderately convergent to the basal angles, which are scarcely distinct; anterior angles distinct but not sharp nor prominent; base and apex not margined, sides finely margined; basal impressions small, rounded, feeble. Elytra as long as the thorax; suture scarcely impressed. Prosternal tuberculation rounded at apex, not broad. Length 2.5 mm., width .5 mm.

*Type locality*.—Cayamas Cuba. (E A. Schwarz).

*Type*.—Cat. No. 26337, U.S.N.M.

*Paratype*.—Cayamas Cuba, 5:3 (E. A. Schwarz).

### OSORIUS VARIOLATUS, new species

Form slightly slender; color black, antennae and legs piceous. Integuments above scarcely at all alutaceous, strongly shining. Head coarsely and rather closely punctate with a rather broad median impunctate stripe, vertex impunctate; thorax coarsely and rather sparsely punctate, punctures elongate, median impunctate stripe bounded by seriate punctures; elytra coarsely, rather closely and subseriately punctate, coarsely and vaguely rugose; abdomen rather coarsely and moderately densely punctate dorsally with a definite median impunctate stripe, punctures on the fifth segment larger and variolate, apical ventral segment coarsely and somewhat sparsely punctate, but not at all rugose. Head slightly narrower than the thorax at apex; clypeus truncate, angles somewhat prominent; antennae extending to the middle of the thorax, joints seven to eleven distinctly larger; eight to ten slightly transverse; joints two and three slightly elongate, subequal; second stouter; first joint as long as the next three. Thorax as long as broad, scarcely wider than the elytra; sides nearly straight and rather strongly narrowed to the basal angles, which are broadly rounded and not distinct, anterior angles narrowly rounded, not at all prominent; sides margin narrow throughout, apex indistinctly margined, base rather distinctly margined. Elytra as long as the thorax; suture absolutely unimpressed. Prosternal tuberculation strong, rounded at apex. Length 4.75–5.5 mm., width 1–7.25 mm.

*Type locality.*—Type and 4 paratypes, Tucson, Ariz., 1, VIII–19 (G. Hofer.); 3 paratypes, Tucson, Ariz., (E. D. Edmonston).

*Type.*—Cat. No. 26338, U.S.N.M., 1 paratype, Tucson, Ariz., 1, VIII–19 (G. Hofer) in the writer's collection.

### OSORIUS DIFFICILIS, new species

Form scarcely slender; color black, attennae, legs and elytral suture paler, piceous. Head rather feebly alutaceous anteriorly, strongly shining; thorax scarcely at all alutaceous; elytra shining, scarcely rugose. Head somewhat coarsely and closely punctate with a rather broad median impunctate stripe, vertex very smooth and shining; thorax rather coarsely and somewhat sparsely punctate; punctures elongate, median impunctate stripe bounded either side by seriate punctures which are somewhat impressed; elytra rather sparsely, indistinctly and irregularly punctate; abdomen rather coarsely and closely punctate dorsally with a definite median impunctate stripe, apical ventral segment moderately punctate but not at all rugose. Head as wide as the thorax at apex; clypeus broadly emarginate, angles not prominent; antennae long, extending beyond the middle of the thorax; joints seventh to eleventh distinctly larger; joints eighth to tenth distinctly transverse; ninth and tenth one-third wider than long; second and third elongate, subequal; third more slender; first joint as long as the next three. Thorax as long as broad, very slightly wider than the elytra; sides distinctly narrowed posteriorly and evenly and rather feebly arcuate to the basal angles which are rounded and not distinct, just perceptibly sinuate before the angles, anterior angles narrowly rounded, not prominent; side margins fine throughout, apex not margined, base distinctly margined; lateral impressions not distinct. Elytra scarcely longer than the thorax, as long as broad; suture slightly impressed. Prosternal tuberculation strong, flattened at the apex. Length 4.5 mm., width 1 mm.

*Type locality.*—30.6 and 1 paratype 2.7 Chiricahua Mountains, Ariz. (Hubbard and Schwarz).

*Type.*—Cat. No. 25339, U.S.N.M. One paratype, Chiricahua Mountains, Ariz., 3.7, VII (Hubbard and Schwarz) in the writer's collection.

### OSORIUS CRENULIFRONS, new species

Form slightly broad; color black, antennae and legs rufo-piceous. Head rather distinctly alutaceous, strongly shining; thorax very faintly alutaceous; elytra very feebly and sparsely rugose. Head very finely and sparsely punctate; thorax finely and a little sparsely punctate; elytra and abdomen subimpunctate, not alutaceous; abdomen beneath alutaceous, basal segments with a few coarse punctures along the apical margins; fifth and apical segments rather coarsely and closely punctate, the latter distinctly rugose and with a rounded median impression. Head narrower than the thorax at apex; clypeus truncate and crenulate in front; front with four foveate punctures and a median impression anteriorly; antennae slender, reaching the middle of the thorax, outer joints not distinctly larger; joints two to six distinctly elongate, outer joints as long as wide; joint three nearly twice as long as the second and as long as the next two; first longer than second and third together. Thorax a third wider than long, base scarcely narrower than the apex, widest at apical third; sides thence nearly straight and moderately convergent to the posterior angles which are obtuse but distinct, anterior angles acute and prominent; side margins distinctly wider posteriorly where they coalesce with rather large and deep basal impressions; apex not margined; base distinctly margined. Elytra scarcely wider than the thorax or wider than long, distinctly longer than the thorax; suture scarcely impressed. Posternal tuberculation strong and rounded at apex. Length 9 mm., width 2 mm.

*Type locality.*—San Diego, Cuba, February 1, 1917 (Wm. Palmer).

*Type.*—Cat. No. 26344, U.S.N.M.

### OSORIUS MANNI, new species

Form scarcely broad; color black, antennae and legs piceous. Head finely alutaceous, a little dull in lustre; thorax less distinctly alutaceous, strongly shining; elytra scarcely rugose, subimpunctate except for a row of five rather coarse punctures along the suture. Head very finely and rather sparsely punctate in front, a few coarse punctures over the eyes; thorax very finely and somewhat densely punctate; abdominal segments dorsally somewhat finely and closely punctate posteriorly, the fifth nearly throughout, pubescence long and coarse, beneath punctures finer and less numerous, apical segment nearly impunctate. Head narrower than the thorax at apex; clypeus and crenulate; front with four foveate punctures and a median anterior and posterior impression; antennae reaching the middle of the thorax, slender, outer joints not larger; two to six distinctly elongate; outer joints as long as wide; third joint twice as long as the second, and as long as the next two; basal joint as long as the next three. Thorax slightly wider than long; base very little narrower than the apex; sides feebly arcuate anteriorly, nearly straight and slightly convergent posteriorly, slightly sinuate before the posterior angles which are obtuse but distinct; side margins slightly wider posteriorly where they coalesce with the moderately large but rather deep basal impressions; apex not margined; base strongly margined. Elytra slightly narrower than the thorax, scarcely shorter; suture not at all impressed. Prosternal tuberculation strong, rounded at apex. Length 11 mm., width 2.25 mm.

*Type locality.*—Pinares Oriente, Cuba, '18 (W. M. Mann).

*Type.*—Cat. No. 26345, U.S.N.M.

### OSORIUS BUSCKI, new species

Form slightly broad; color black, legs, antennae and elytral suture piceous. Head distinctly alutaceous and subopaque; thorax scarcely alutaceous; elytra scarcely rugose, both strongly shining; abdomen shining. Head very finely, sparsely and somewhat indistinctly punctured, a few strong punctures over the eyes; thorax somewhat finely and closely punctured; elytra impunctate; abdomen rather coarsely and closely punctured above especially on the fifth segment, closely punctured beneath, apical segment impunctate. Head distinctly narrower than the thorax at apex; clypeus truncate and crenulate; front with four foveate punctures in a transverse row, another on either side of the vertex; antennae reaching the middle of the thorax; outer joints scarcely larger; joints five to ten moniliform; third joint one-half longer than the second; fourth joint very slightly elongate; basal joint as long as the next two. Thorax scarcely transverse; base slightly narrower than the apex; sides feebly arcuate anteriorly, nearly straight and slightly convergent posteriorly, just visibly sinuate before the obtuse but distinct posterior angles; anterior angles very minutely denticulate; side margins very slightly wider posteriorly, basal impressions feeble; apex not margined; base distinctly margined. Elytra slightly narrower, scarcely shorter than the thorax, as wide as long; suture scarcely impressed. Prosternal tuberculation more broadly rounded at apex. Length 4.75 mm., width 1 mm.

*Type locality.*—Santo Domingo, W. I. 7–8 (Aug. Busck).

*Type.*—Cat. No. 26346, U.S.N.M.

*Paratype.*—San Antonio de los Banos, Cuba. (Jose H. Pazos, collector.)

### OSORIUS CONFUSUS, new species

Form somewhat broad; color black, outer antennal joints, palpi and tarsi piceous. Head rather feebly alutaceous anteriorly; thorax distinctly alutaceous except medially at the base; elytra distinctly but irregularly longitudinally rugose; the basal dorsal abdominal segment strongly alutaceous, the remaining smooth, shining and subimpunctate, ventral segments alutaceous with a few coarse punctures along the apical margin back to the middle; the apical segment rather feebly strigose-punctate laterally. Head coarsely and rather closely punctate, vertex smooth, strongly shining; thorax coarsely but less closely punctate than the head. Elytra finely, sparsely and indistinctly punctate. Head as wide as the thorax at apex; clypeus bisinuate, angles bluntly prominent and denticulate internally, middle lobe less prominent and more broadly rounded; antennae short, not reaching the middle of the thorax; outer joints not larger, moniliform; second and third slightly elongate, subequal in length and thickness, not stouter than the fourth; first joint as long as the next five. Thorax one-third wider than long; base narrower than the apex; sides feebly convergent and nearly straight to behind the middle; thence somewhat abruptly more convergent and broadly sinuate to the posterior angles which are obtuse but distinct and narrowly rounded; side margins distinctly wider posteriorly, basal impressions broad and rather feeble, apex unmargined, base distinctly margined; canaliculation one-half the length of the thorax, strong and rather deeply impressed. Elytra scarcely wider than the thorax, slightly wider than long, slightly longer than the thorax; suture strongly impressed. Prosternal tuberculation broad, emarginate at apex. Length 10 mm., width 2.25 mm.

*Type locality.*—Omealca, Vera Cruz, Mexico, April 16, '08 (Fred. Knab).

*Type.*—Cat. No. 26347, U.S.N.M.

### OSORIUS MORIO, new species

Form scarcely broad; color black, apical antennal joints, palpi and tarsi paler. Head scarcely alutaceous, strongly shining; thorax not at all alutaceous; elytra with scattered and irregular channels; basal dorsal abdominal segment alutaceous, the remainder strongly shining and subimpunctate, ventral segments more or less alutaceous basally, apical halves coarsely punctate and smooth, fifth segment almost entirely so, apical strongly and uniformly rugose punctate. Head rather coarsely and closely punctate anteriorly, vertex smooth and shining, no median impunctate stripe; thorax moderately coarsely and somewhat sparsely punctate; elytra coarsely and sparsely punctate. Head as wide as the thorax at apex; clypeus bisinuate, the angles bluntly prominent and bidenticulate internally, median lobe less prominent and very broad; antennae short, slightly surpassing the apical margin of the thorax; outer joints scarcely larger, moniliform; second and third joints slightly elongate, subequal in length and thickness, not stouter than the fourth; basal joint as long as the next four. Thorax slightly wider than long, base distinctly narrower than the apex; sides very feebly narrowed and nearly straight from the apex to the middle, thence somewhat abruptly more narrowed and broadly sinuate to the rather broadly rounded and somewhat indistinct and obtuse posterior angles; anterior angles somewhat minutely denticulate; side margins distinctly wider posteriorly, basal impressions very feeble; canaliculation nearly one-half the length of the thorax, coarser but feebly impressed, apex unmargined, base strongly margined. Elytra slightly narrower than the thorax, slightly transverse and scarcely shorter than the thorax; suture moderately impressed. Prosternal tuberculation broad and truncate at apex. Length 10 mm., width 2 mm.

*Type locality.*—Omealca, Vera Cruz, Mexico, April 16, 1908 (Fred. Knab).

*Paratype locality.*—Jalapa, Mexico (W. Schaus). Nine paratypes in the collection of the American Museum of Natural History; one paratype in the writer's collection. One paratype Cordoba, Mexico, 12-VI (Fred. Knab).

*Type.*—Cat. No. 26348, U.S.N.M.

In addition to the species described as new, the following are identified in the material studied. Those marked (A. M.) are in the collection of the American Museum of Natural History.

### OSORIUS ATER Perty

Brazil. Santa Catharina. (A. M.)

### OSORIUS EGGERSI Bernhauer

Paraiso, C. Z., Pan., January 19 and February 3, 1911. August Busck.

Paraiso, C. Z., Pan., January 21, 1911. E. A. Schwarz.

Montego Bay, Jamaica, March 10, 1911 (sifting). Grossbeck. (A. M.)

Santiago de Cuba. (A. M.)

### OSORIUS POLITUS LeConte

Enterprise, Fla., May 19 and 29 and June 15. Collectors, Hubbard and Schwarz.

Crescent City, Fla., February 19. Collectors, Hubbard and Schwarz.

### OSORIUS SALVINI Sharp

S. Geronimo, Guatemala. Champion.

Paraiso, C. Z., Pan., January 19, 22, 1911. E. A. Schwarz.

Panzos, Vera Cruz. Champion.

Panzos, Vera Cruz. Champion. (A. M.)

### OSORIUS PLANIFRONS LeConte

Memphis, Tenn., August 11. H. Soltau, collector.

New Orleans, La. H. Soltau, collector.

Crescent City, Fla. Collectors, Hubbard and Schwarz.

S. Rita Mountains, Ariz., June 14. Collectors, Hubbard and Schwarz.

New Orleans, La. Collector, Chas. Palm. (A. M.)

La. (A. M.)

La. Sh. Jr. (A. M.)

Jalapa, Mexico. W. Schaus. (A. M.)

### OSORIUS MICROS Sharp

Cayamas, Cuba, 13–2. E. A. Schwarz, collector.

### OSORIUS MUNDUS Sharp

Mexico. D. F. J. R. Inda, collector.

Chiantla, Mexico.

Mexico City, Mexico. (O. W. Barrett.)

State of Colima, Mexico. (L. Conradt.)

Orizaba, Vera Cruz, Mexico, January 9–16, '92 (H. Osborn), in the writer's collection.

### OSORIUS LATIPES Gravenhorst

Brookings, S. Dak. H. Osborn, collector. Webster No. 7005.

Topeka, Kans. Collectors, Hubbard and Schwarz.

Sioux City, Iowa, April 21. H. Soltau, collector.

Kansas City, Mo., May 25 and 30. H. Soltau, collector.

Blue Springs, Mo., September 18. H. Soltau, collector.

Pine Bluff, Ark., October 10. H. Soltau, collector.

Columbus, Tex., August 16 and 27, September 22–7. Collectors, Hubbard and Schwarz.

Greenville, Tex., June 30, 1904. H. S. Barber, collector.

Huntsville, Ala., May 10, 1882. L. O. Howard.

Dallas, Tex., April 26, 1907. (Schwarz and Pratt), 30 March, 1907; (W. A. Hooker), 29 June, 1905 (W. E. Hinds).

Chevy Chase, Md., August 8, December 21, September 30, 1921. H. S. Barber, collector.

Falls Church, Va., May 5, 1915. T. E. Snyder, collector.

Black Mountains, N. C., May 31. (A. M.)

S. Dak. C. F. B. Aldrich. (A. M.)

Ky. Collector, Chas. Palm. (A. M.)

Ks. Collector, Chas. Palm. (A. M.)

### OSORIUS BREVICORNIS Notman

Timms Hmk, Dade Co., Fla. February 24, 1919. H. S. Barber.

Enterprise, Fla., November 13 and June 23. Collectors Hubbard and Schwarz.

Capron, Fla., March 4. Collectors Hubbard and Schwarz.

Colima, Col., Mex. Conradt.

Crescent City, Fla., Collectors Hubbard and Schwarz.

### OSORIUS BRASILIENSIS Guérin

S. Bernadino, Paraguay. K. Fiebig, collector.

### OSORIUS STIPES Sharp

Duschi, Rio Beni, Bolivia, September. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Ivon, Beni, Bolivia, February. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Lower Rio Madidi, Bolivia, February. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Rurrenabaque, Rio Beni, Bolivia, October. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Tumupasa, Bolivia, December. (M. R. Lopez.) Mulford Bio-Expl., 1921–22.

Sta Helena, Bolivia, August. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Rio Negro, Bolivia, January. (W. M. Mann.) Mulford Biol-Expl., 1921–22.

Covendo, Bolivia, 1921. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

### OSORIUS ALTERNANS Bernhauer

Sta Helena, Bolivia, August. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

Huschi, Rio Beni, Bolivia, September. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

### OSORIUS CANALICULATUS Solsky

Trece Aguas, Guatamala, April 22. O. F. Cook, collector.

Cordoba V. C. Mex., January 20, 1908. Frederick Knab, collector.

### OSORIUS VICINUS Sharp

San Carlos, Costa Rica. Collectors, Schild and Burgdorf.

### OSORIUS PUNCTICEPS Sharp

Jalapa, Mex., March. Ex-collector, Mus. Nat. Mex.

### OSORIUS NITENS Sharp

Rio Negro, Bolivia, January. (W. M. Mann.) Mulford Bio-Expl., 1921–22.

### OSORIUS INTERMEDIUS Erichson

San Carlos, Costa Rica. Collectors, Schild and Burgdorf.

### OSORIUS LAEVIGATUS Sharp

Cascades, Trece Aguas, Guatemala. Alta V, Paz, Guatemala. O. F. Cook, collector.

### CATALOGUE OF OSORIUS LATREILLE FROM NORTH AND SOUTH AMERICA

*affinis* Sharp. Trans. Ent. Soc. London, 1876, p. 385. Amazon.
*argentinus* Bernhauer. Deuts. Ent. Zeits., 1911, p. 403. Argentina.
*asymmetricus* Fauvel. Rev. d'Ent., vol. 20, 1901, p. 72. Venezuela.
*ater* Perty. Del. anim., 1834, p. 30, pl. 7, fig. 1. Brazil.
*boops* Sharp. Biol. Centr.-Amer., ser. 2, vol. 8, 1882–1887, p. 679. Panama.
*brasiliensis* Guérin. Ic. Ins., 1829–1844, pl. 9, fig. 11*a–d*. Brazil.
*breviceps*, new species, see p. 12. Paraguay.
*brevicornis* Notman. Bull. Amer. Mus. Nat. Hist., vol. 42, 1920, p. 698. Florida.
*brevipennis*, new species, see p. 14. Arizona, Mexico, Panama, Guatemala.
*buscki*, new species, see p. 19. Santo Domingo, W. I.
*canaliculatus* Solsky. Bull. Moscou, vol. 42, 1869, p. 265. Mexico.
*carinicollis*, new species, see p. 15. Guatemala.

*confusus*, new species, see p. 20. Mexico.
*cordovensis* Bernhauer. Verh. zool.-bot., Ges. Wien, vol. 60, 1910. p. 360. Mexico.
*crassus* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 681. Mexico.
*crenulifrons*, new species, see p. 18. Cuba.
*cylindricus* Latreille. Nouv. Ann. Mus., Paris, vol. 8, 1832, p. 86. Mexico.
*debilis* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 681. Panama.
*dentatus* Bernhauer. Arch. Natg., 1908, p. 294. Bolivia.
*difficilis*, new species, see p. 17. Arizona.
*dubius* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 679. Panama.
*eggersi* Bernhauer. Verh. zool.-bot. Ges. Wien, vol. 54, 1904, p. 19. St. Thomas, W. I.
*exiguus*, new species, see p. 16. Cuba.
*frater* Lynch. Estaf. Buenos Aires, Bol. Ac. Nac. Cord., vol. 7, 1884, p. 345. Argentina.
*germanus* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 680. Guatemala.
*hirtulus* Fauvel. Rev. d'Ent., vol. 10, 1891, p. 92. Venezuela.
*hubbardi*, new species, see p. 11. Jamaica, W. I.
*integer* Sharp. Trans. Ent. Soc. London, 1876, p. 384. Amazon.
*intermedius* Erichson. Gen. Spec. Staph., 1840, p. 754. Colombia.
*laeviceps*, new species, see p. 15. Porto Rico.
*laevicollis* Bernhauer. Arch. Natg., 1908, p. 294. Bolivia.
*laevigatulus* Schubert. Deuts. Ent. Zeits., 1911, p. 4, Brazil.
*laevigatus* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 679. Guatemala.
*laeviusculus* Bernhauer. Beilage zur Zeits. fur wiss. Ins-biol., vol. 2, p. 9 (1920). Brazil.
*latimargo* Bernhauer. Arch. Natg., 1908, p. 294. Peru.
*latipes* Gravenhorst. Mon. Col. Micr., 1806, p. 198. North America.
*manni*, new species, see p. 19. Cuba.
*mexicanus* Bernhauer. Verh. zool.-bot. Ges. Wien, vol. 60, 1910, p. 360. Mexico.
*micros* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 682. Guatemala.
*minor*, new species, see p. 14. Trinidad, W. I.
*morio*, new species, see p. 21. Mexico.
*mundus* Sharp. Trans. Ent. Soc. London, 1876, p. 432. Mexico.
*neotropicus* Bernhauer. Arch. Natg., 1908, p. 295. Brazil.
*nitens* Sharp. Trans. Ent. Soc. London, 1876, p. 382. Amazon.
*oculatus* Sharp. Trans. Ent. Soc. London, 1876, p. 386. Amazon.
*opacifrons* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 680. Mexico.
*parcus* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 680. Central America.

*parviceps*, new species, see p. 12. Florida.

*parvulus* Scriba. Stettin. Ent. Zeits., vol. 16, 1855, p. 300. Venezuela.

*peruvianus* Bernhauer. Arch. Natg., 1908, p. 293. Peru.

*piceus* Erichson. Gen. Spec. Staph., 1840, p. 755. Brazil.

*planifrons* J. L. LeConte. Trans. American Ent. Soc., vol. 6, 1877, p. 215. North America.

*politus* J. L. LeConte. Trans. American Ent. Soc., vol. 6, 1877, p. 2 ″5. Florida.

*puncticeps* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 678. Mexico.

*pygmaeus* Castelnau. Etud. Ent., vol. 6, 1835, p. 130. Cayenne.

*rugipennis* Bernhauer. Verh. zool.-bot. Ges. Wien, vol. 60, 1910, p. 361. Mexico.

*salvini* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 682. Guatemala.

*schwarzi*, new species, see p. 13. Cuba.

*sexpunctatus* Bernhauer. Ent. Blatt. Berlin, vol. 8, p. 168 (1912), Argentina.

*simplex* Sharp. Trans. Ent. Soc. London, 1876, p. 383. Amazon.

*solidus* Sharp. Trans. Ent. Soc. London, 1876, p. 384. Amazon.

*stipes* Sharp. Trans. Ent. Soc. London, 1876, p. 382. Amazon.

*sublaevis* Bernhauer. Beilage zur Zeits. wiss. Ins. -biol., vol. 2, p. 9. (1920). Paraguay.

*variolatus*, new species, see p. 17. Arizona.

*vicinus* Sharp. Biol. Centr.-Amer., ser. 2, vol. 1, p. 678. Panama.

# A NEW SPECIES OF POLYCHAETOUS ANNELID FROM URUGUAY, APHRODITA MAGNA

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While engaged in the study of the fur-seal and other fisheries of Uruguay, Dr. Hugh M. Smith, former United States Commissioner of Fisheries, secured a large specimen of *Aphrodita* at Cape Polonia, on December 6, 1922. This specimen, sent me for determination by the authorities of the United States National Museum, proves to be a hitherto undescribed species.

## APHRODITA MAGNA, new species

The holotype (Cat. No. 19124, United States National Museum) is 111 mm. long and 50 mm. in greatest width when measured to the tips of the parapodia and has approximately 40 somites. Dorsally it is characterized by the unusual development of the large dark-brown and more or less iridescent setae which form a dense fringe along either side of the dorsum and extend to a distance of fully 25 mm. beyond the point of their emergence from the felt. From 10 to 15 of these large setae occur in each somite. The felty covering is very dense and tough, covering the dorsal surface in a band from 25 to 30 mm. wide, and filling all of the spaces between the large setae. The ventral surface has no very noticeable median furrow and has a granular appearance due to the presence of an immense number of globular or oval papillæ which are slightly darker in color than the general surface of the body.

The prostomium (fig. 1) is roughly pear-shaped with the broader end anterior and the narrow portion continued posteriorly as a parallel-sided area which merges with the first somite. When first exposed by the removal of the dorsal felt a single pair of eyes could be seen on the side of the prostomium. After standing for some time in alcohol these became invisible. The cirrophore of the median

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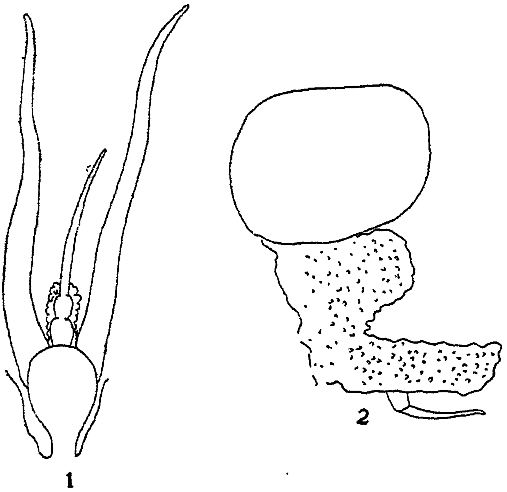
tentacle is slightly constricted at the base and divided by a constriction into a proximal and a distal portion, of which the former is the larger. The style is slender and is about one and one-half times the length of the prostomium. The facial caruncle is very large and the palps are unusually well developed.

The first parapodium lies close to the prostomium and is about equal to it in length. The notopodium is larger than the neuropodium and irregularly lobed. A slender dorsal cirrus arises from a heavy cirrophore situated a little below the dorsal margin. The neuropodium is two-lobed and carries a cirrus similar in form to the dorsal one with its cirrophore on the posterior face of the neuropodium. A single acicula comes to the surface between the two lobes. The second parapodium is markedly different from the first and the two lobes are sharply separated from one another. The neuropodium is long and cylindrical, obliquely truncated at the end, and has a few dark-brown setae. The notopodium expands distally from a narrow base and carries the large milk-white smooth elytron. In the notopodium are a few of the dark-brown setae which extend dorsally through the felt, and a few slender ones.



FIGS. 1 AND 2.—1, ANTERIOR END ×7.5. THE LARGE FACIAL TUBERCLE IS SHOWN UNDER THE MEDIAN TENTACLE. 2, FOURTH PARAPODIUM ×2. THE ELYTRON IS BENT SO AS TO LIE PARALLEL WITH THE VERTICAL FACE OF THE PARAPODIUM

The fourth parapodium (fig. 2) has a long cylindrical notopodium like the second but longer. A slender ventral cirrus arises from a heavy cirrophore. The rounded notocirrus has at the apex a tuft of the slender setae and dorsally some of the heavy brown ones. The elytron (foreshortened in the drawing) is smooth, nearly circular in outline, and rather delicate. Later somites show an increase in the length of the parapodia, followed by a gradual decrease toward the posterior end of the body. There are 15 pairs of elytra.

The neuropodial setae differ from one another only in size and color and their arrangement is characteristic. At the anterior end of the dorsal margin of the obliquely truncated outer end of the neuropodium the colorless acicula comes to the surface. Posterior to this two large dark-brown setae protrude in such a fashion that they form with the acicula an equilateral triangle. Ventral to these is a horizontal row of not more than four similar but smaller setae, and ventral to these and parallel with them is a second row which may have as many as seven setae. These are more slender than the dorsal ones but in other respects are similar to them.

The large dorsal setae resemble the ventral ones in form but are much larger. The smaller ones, which form a dense tuft at the apex of the notopodium, are slender and threadlike with sharp points.

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# REVISION OF BUGS OF THE FAMILY CRYPTOSTEMMATIDAE IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

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The present paper is based chiefly on specimens in the collection of the United States National Museum. We have, however, had the great advantage of a loan of material, including types, from the Zoological Museum at Helsingfors, Finland; for this we are greatly indebted to Dr. Richard Frey and to Dr. E. Bergroth. H. G. Barber also has kindly loaned a considerable number of specimens of the genus *Ceratocombus*. This aid has enabled us to make the present paper practically a revision of the known American species.

We adopt the family name Cryptostemmatidae based on that of the oldest genus; this course should satisfy also adherents of the so-called type-genus method of selecting family names as *Cryptostemma* preoccupies *Dipsocoris* upon which the supposed oldest family name for the group was based. At least two other names also have been applied to the family.

Reuter used the name Ceratocombidae in his monograph of 1891 (see bibliography) and recognized two subfamilies. This latter policy we follow, though meanwhile these groups have been ranked as families by various authors, and Reuter, treating them so in 1910,[1] made the assemblage one of the primary divisions in his system of the Heteroptera.

The definition of this series which he called Trichotelocera in no way distinguishes these insects from certain Anthocoridae and Cimicidae. The more distinctive characters are not mentioned at all and the whole effort impresses us as very weak considering the high taxonomic rank given the assemblage. The Cryptostemmatinae agree in many particulars with some Anthocoridae[2] (Lyctocorinae), as in number of segments of tarsi, beak, and antennae, and in the slenderness and pilosity of the apical two segments of latter, possession of ocelli, definite chaetotaxy of head and pronotum, bristly tibiae, and in having the costa thickened and provided with a fracture (forming what are called embolium and cuneus).

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[1] Der Miriden, Acta Soc. Sci. Fenn. 37, No. 3, 1910, p. 67.

[2] This was noted by Haliday in 1855.

Upon consideration it becomes apparent, however, that having characters in common does not necessarily imply relationship. The eternal question of taxonomy arises, as to whether characters are of phyletic significance or are mere parallelisms. The antennal and chaetotactic characters so similar in Cryptostemmatids and Lyctocorids may be only parallel adaptations in groups frequenting similar environments. On the other hand, the excessive development of the coxae in Cryptostemmatids which has resulted in great diminution in size of the pleura and conceivably may have had to do with lack of metapleural ostioles, itself is an adaptive character in these jumping insects. However, when we note that the Schizopterids also have no ostioles (although their pleura are well developed) and agree with the Cryptostemmatids, not only in the more ordinary tarsal, rostral, and antennal details, but also in peculiar venational characters, we must conclude that the two groups, though distinct, yet are more closely related to each other than to the remaining known Heteroptera.

How high a rank they should be given in a general scheme of classification is a matter impossible to decide satisfactorily until the characters of all Heteroptera have been more closely scrutinized and evaluated. We content ourselves for the present, therefore, in saying that the more distinctive characters of the group are: absence of metapleural ostioles, possession of only 5 or 6 exposed ventral segments, and the characteristic texture and venation of the wings. The fore wings may be entirely coriaceous or entirely membranous but hardly ever are so differentiated in texture that a definite membrane can be recognized. The definite venation of the basal part of the fore wings, and the extension of one or two longitudinal veins entirely to the apical margin, are distinctive. The hind wings have more or less incised margins, simple longitudinal veins, and so far as observed no cross veins (figs. 5–7, 47). The less significant characters of antennae, beak, and tarsi, already mentioned, in connection with the small size of the insects, are useful for ordinary recognition of the group.

### KEY TO THE SUBFAMILIES

1. Propleurum normal to reduced in size, never swollen anteriorly below eyes; coxae greatly developed, occupying pleural spaces so that only the proplerum is near normal size, metapleurum almost suppressed; anterior width of scutellum over one-half that of hind margin of pronotum; costa of fore wing with a definite fracture in macropterous forms; vein along hind margin of clavus crossing clavus obliquely some distance before apex; one or two free veins in apex of wing of macropterous forms (figs. 1–4, 8–9); head usually more porrect and less deeply set into the

thorax, than in the contrasted group, eyes projecting laterally, scarcely overlapping anterior angles of pronotum; head and tibiae usually with strong bristles; hypopygium of male with two or three pairs of distinct clasping organs (fig. 12); abdomen of female in *Ceratocombus* not depressed, the apical tergite almost vertical, with a small round opening near its lower margin which is always visible from behind; in *Cryptostemma* the abdomen of female is as in Schizopterinae__**Cryptostemmatinae.**

Propleurum in most cases much swollen and extending forward as far as or farther than anterior margin of eye (figs. 16–19); coxae usually less developed; scutellum small, its anterior width not over one-third as great as hind margin of pronotum; costa of fore wing without fracture; vein along hind margin of clavus strictly marginal, not crossing clavus before apex; three free veins in apex of wing of macropterous forms (various figures on pl. 3); head usually more transverse and more deeply set into the thorax, the eyes projecting laterally and posteriorly, overlapping anterior angles of pronotum; head and tibiae usually without strong bristles (figures on pl. 2); hypopygium of male without noticeable paired clasping organs, but with a long coiled hairspring-like attachment which lies on dorsum of abdomen and is not visible from below (figs. 83–84), the apical tergite assymmetrical and frequently furnished with processes on left side (figures on pl. 4); abdomen of female always depressed, apical sternite uncleft, anal opening at apex on dorsum.
**Schizopterinae.**

## Subfamily CRYPTOSTEMMATINAE

A number of general characters of the subfamily are mentioned in the introduction and in the key to subfamilies and we may add that these insects are notable for their vestiture, being clothed above with a very fine pilosity, with longer hairs on wing veins and costal margin, the hairs on or near margins of thorax also are longer, certain of them sometimes being developed as bristles, the head with paired bristles, of which one between back part of eyes, and about three from lower margins of eyes to clypeus appear to be present in all the species (some have several more especially on base of beak); the antennae are long-haired throughout (fig. 10). The under surface also is copiously pilose, the sides of abdominal segments, especially posteriorly, with longer hairs, and the tibiae are bristly. The male genitalia (described in keys to subfamilies and genera) are remarkable. There is little range of color in the family and the species, whatever shade of the characteristic family coloration they exhibit, are mostly very uniformly colored throughout.

### KEY TO THE GENERA

1. Fore wing with a break about middle of costa in macropterous forms which does not extend to disk, the venation as in figures 1–4; second segment of antenna three or more times as long as first (fig. 10); apical tergite of abdomen in females large, covering the apex of abdomen, with a small round anal opening above its lower margin, apical sternite large in same sex, generally occupying about half of venter, the ovipositor retractile, the sheaths with distinct teeth; genitalia of male with pairs of symmetri-

cal clasping organs, the basal pair large, emanating from lateral margins of the segment in front of base of the hypopygium proper (fig. 12).
**Ceratocombus** Signoret.

Fore wing with a distinct fracture about middle which extends midway across disk, the venation as in figures 8–9; second segment of antenna more than twice as long as first; apical tergite of abdomen in female not noticeably enlarged; apical sternite in same sex not nearly half the length of venter; hypopygium of male with similar claspers but apparently only on one (the left) side in the single specimen examined (fig. 14).
**Cryptostemma** Herrich-Schäffer.

### Genus CERATOCOMBUS Signoret

*Ceratocombus* SIGNORET, V, Ann. Soc. Ent. France, ser. 2, vol. 10, 1852, p. 542, pl 16, fig 3 [Monobasic, proposed at end of description of *Astemma mulsanti*, new species, pp. 541–2, France] This species is a synonym of *Anthocoris coleoptratus* Zetterstedt, hence that species is the genotype.

*Lichenobia* v. BAERENSPRUNG, Berlin Ent. Zeitschr., vol. 1. 1857, pp. 165–167 [Monobasic, *L. ferruginea*, new species, genotype, Germany]. The genotype is synonymous with *Ceratocombus coleoptratus* genotype of that genus, hence the name is an exact synonym of *Ceratocombus*.

Reuter (Monograph, 1891) divides the genus *Ceratocombus* into four subgenera, as follows:

*Leptonannus*, new subgenus, p. 5 [Monobasic, type species *C.* (*L.*) *biguttulus*, new species, Africa, p. 5, fig. 1].

*Trichotonannus*, new subgenus, pp. 5–6 [Monobasic, type species *C.* (*T.*) *setulosus*, new species, Nangkovri, pp. 5–6, fig. 2].

*Ceratocombus* (Signoret), p. 6, type species as in generic reference.

*Xylonannus*, new subgenus p. 8, [included species, two: *C.* (*X.*) *corticalis* Reuter, Finland, pp. 8–9, fig. 5, and *C.* (*X.*) *boliviensis*, Bolivia, p. 9, of which the former was designated as type by Oshanin in 1912].

Poppius has added ('15, p. 77) the subgenus *Tagalonannus*, type species *C.* (*T.*) *coloratus*, new species [Philippines].

Three subgenera are represented in the American material before us, and we identify them as *Ceratocombus*, *Leptonannus*, and *Xylonannus*. We have seen both of the species, namely, *coleoptratus* Zetterstedt and *brasiliensis* Reuter, that Reuter included in the typical subgenus. *C. latipennis* Uhler and *C. minutus* Uhler have the same venation of the forewings as figured by Reuter for the type species of *Leptonannus* and belong here, we believe, although the hind wings are bilobate instead of trilobate as described and figured for the subgenotype. *Xylonannus* has a good venational distinction and we assign to this subgenus four of the species in our material. No representatives of the other subgenera have been examined. We do not overlook Reuter's proposal[3] that *Leptonannus* be given full generic rank, but we do not accept it.

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[3] Hemipterologische Miscellen, Öfv. Finska Vet.-Soc. Förh., vol. 54, p. 65, 1912.

### KEY TO THE SPECIES

1. Species with a broad cream-colored fascia[4] occupying basal third of forewings; remainder of dorsum brownish-black............**fasciatus** Uhler.
   Species colored otherwise............ 2
2. Forewing with a small closed triangular cell exterior to apex of clavus (figs. 3–4); a bristle behind eye and two on lateral margin of pronotum ............ 3
   Forewing lacking the small closed cell (figs. 1–2); no bristle behind eye nor on lateral margin of pronotum (Subgenus *Xylonannus* Reuter)... 6
3. Two veins emanating from discal cell of forewing (Subgenus *Ceratocombus* Signoret.) (fig. 4)............ 4
   Only one vein emanating from discal cell of forewing (Subgenus *Leptonannus* Reuter.) (fig. 3)............ 8
4. Forewings glassy in texture, fumose hyaline, the veins opaque, narrowly dusky margined............**areolatus**, new species.
   Forewings not glassy in texture, more opaque, yellowish brown to fuscous, paler in part of the cells............ 5
5. Length 1.75 mm............**brasiliensis** Reuter.
   Length 1.25 mm............**hesperus**, new species.
6. Length 2 mm. or more; discal cell of forewing nearly parallel-sided (fig. 1). **major**, new species.
   Length less than 2 mm.; discal cell of forewing not parallel-sided (fig. 2)............ 7
7. First apical cell smaller than second; forewing slightly lustrous, outer third and clavus denser in texture than remainder, the wedge-shaped area between, paler............**cuneatus**, new species.
   First apical cell larger than second (fig. 2), forewing highly shining, without a percurrent wedge-shaped paler portion............**vagans**, new species.
8. Second rostral segment with at most three pairs of fine dorsal hairs which are at least as long as its diameter............**minutus** Uhler.
   Second rostral segment with six or more pairs of fine dorsal hairs which are not as long as its diameter............ **latipennis** Uhler.

### CERATOCOMBUS FASCIATUS Uhler

*Cryptostemma fasciatum* UHLER, P. R., Proc. Zool. Soc. Lond., 1894 (March 6), p. 197 [Grenada].

*Dipsocoris fasciatus* LETHIERRY L., and SEVERIN, G., Cat. Gen. Hemip., vol. 3, 1896, p. 232.

We have two brachypterous females of this species, one a paratype. On account of the leathery texture of the wings it is difficult to trace the venation, but there are evidently two veins emanating from the discal cell, and from the distribution of the longer hairs, a small cell at inner angle of corium is indicated. In one specimen there is a distinct bristle near anterior angle of pronotum, indicating the probability that this species belongs to the subgenus *Ceratocombus*. The broad cream-colored band across bases of fore wings readily distinguishes this from any other described species. Length, 1 mm.

One specimen from Grenada, and one from St. Vincent, H. H. Smith.

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[4] We use this color character to key *C. fasciatus* because the venational characters are so difficult to make out; as we have seen them, however, they indicate that this species is referable to the typical subgenus.

### CERATOCOMBUS (CERATOCOMBUS) AREOLATUS, new species

Head, pronotum, and scutellum castaneous, the fore wing with a pale streak traversing the clavus, the costa and veins dark, and areoles pale as described in key; body color beneath paler than above, legs testaceous. Venation of fore wing as in figure 4. Length, 1.75 mm.

*Holotype.*—Female, Cacao Trece Aguas, Guatemala, April 20, E. A. Schwarz and H. S. Barber; paratypes, both sexes, Cordoba, Vera Cruz, Mexico, May 13, 15, 1908, F. Knab. Cat. No. 27569, U.S.N.M.

### CERATOCOMBUS AREOLATUS, var. ACCOLA, new variety

Differs from the foregoing, so far as we can be certain, only by more uniform coloration of the fore wings; the general body color in most specimens also is paler. Length, 1.25–1.75 mm.

*Holotype.*—Female, Grenada, H. H. Smith; also two males with same data. Cat. No. 27570, U.S.N.M.

### CERATOCOMBUS (CERATOCOMBUS) BRASILIENSIS Reuter

*Ceratocombus* (*C.*) *brasiliensis* REUTER, Monograph, 1891, p. 7, fig 3 [Bahia].

We have examined a specimen from La Moka, labelled Spec. typ. No. 3429, Mus. Zool. Helsingfors by Poppius. The preceding species *areolatus*, while closely related, is easily distinguished by the characters given in the key. The West Indian records of *brasiliensis* refer to the species subsequently described under the name *major*, and the New Mexican record of the same species to *latipennis* Uhler.

### CERATOCOMBUS (CERATOCOMBUS) HESPERUS, new species

Head and thorax castaneous; fore wings a little paler, shining; lower surface yellowish-brown, the apex of abdomen dusky. Other characters as noted in key. Length, 1.25 mm.

*Holotype.*—Female, paratype female, and a damaged specimen (female), Palm Springs, Calif., 7.2, H. G. Hubbard. All brachypterous. Cat. No. 27571, U.S.N.M.

### CERATOCOMBUS (XYLONANNUS) MAJOR, new species

Varies in body color from pale to dark castaneous, the fore wings with the veins varying from fulvous to almost black and the membranous parts from yellowish fumose to dusky, in the latter case, however, a large, more translucent, spot remains at apex of corium; antennae and legs stramineous. In keeping with its size, this really robust species, for the family, has all the bristles strong and readily seen. All the specimens we have examined are macropterous and exhibit characters that seem clearly associated with this condition, namely, pronotum being much wider behind than in front, and the apical constriction well developed so that there is a distinct collum. Eyes distinctly higher than wide, broadly emarginate behind; in all others of the genus seen the eyes are nearly round; clasper of male as in figure 13; venation of fore wing as in figure 1; hind wing as in figure 5. Length, 2–2.25 mm.

Sixteen specimens from Grenada and St. Vincent, West Indies (H. H. Smith), of which a male from the former island is selected as holotype. Cat. No. 27572, U. S. N. M.

The description of *Ceratocombus bifenestratus* Poppius[5] applies very well to the preceding species, but Poppius compares his species with *C. brasiliensis* Reuter and assigns it to *Ceratocombus* (s. s.), so we assume it has the small closed cell in corium just exterior to apex of clavus (as figured for *brasiliensis*) which is lacking in *C. major*. In *Ceratocombus* (s. s.) the species seems nearer to *brasiliensis* than to any other included in our key.

### CERATOCOMBUS (XYLONANNUS) CUNEATUS, new species

General color above fuscous, lustrous in reflected light as usual in the genus, a pale spot in forewing near costal fracture; the vein which separates the two apical cells is present in each elytron, although difficult to see, and that in the left tegmen is forked. The legs are yellowish-brown and copiously bristly. Length, 1.5 mm.

*Holotype.*—Male, Blumenau, Santa Catharina, Brazil. (Mus. Helsingfors.)

### CERATOCOMBUS (XYLONANNUS) VAGANS, new species

Color of head, pronotum, and scutellum pale chocolate brown to castaneous, of forewings uniform drab to pale brown; antennae and legs stramineous. Even in macropterous forms the apical constriction of pronotum is broadly interrupted in the middle; an impressed line parallels hind margin of pronotum and there is a pair of well separated foveae on disk just behind middle; usually a median longitudinal impressed line is visible on pronotum, and sometimes a similar but fainter canaliculation on scutellum. Claspers of male as in figures 11–12; venation of forewing as in figure 2; hind wing, figure 7. Length, 0.75–1.75 mm.

*Holotype.*—A macropterous male, Glen Echo, Md., sifted from fallen leaves, September 3, 1922, J. R. Malloch; allotype and numerous paratypes of both sexes, as well as nymphs with the same data; other paratypes: Glen Echo, Md., July 12, 1922, J. R. Malloch, a single female, which was captured while biting the collector; Plummer Island, Md., August 10, 1902, August 29, 1905, September 15,

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[5] Öfv. Finska Vet.-Soc. Förh., vol. 52, 1909–1910, Afd. A, no. 1, pp. 1–2 [Guadeloupe].

1907, October 22, 1905, and a few other dates, E. A. Schwarz, H. S. Barber, O. Heidemann; Hyattsville, Md., September 18, 1913, Paint Branch, two miles west of Beltsville, Md., July 30, 1922; Washington, D. C., issued April 5, 15, 1913, from rotten pine wood collected at Piney Branch; Timm's Hammock, Dade County, Fla., February 24, 1919, H. S. Barber; Porto Bello, Panama, February 23, 1911, E. A. Schwarz; Paint Branch, Md., same data as above, Vienna, Va., August 17, 1922, H. G. Barber; Keene Valley, N. Y., June 29, 1917, H. Notman.

The name *Ceratocombus niger* Uhler[6] may possibly have been applied to specimens of this widely distributed species. However, the holotype of *C. niger* is lost, and the other specimen mentioned in connection with the original description as "somewhat distorted" is in too poor condition for identification. It is possible also that the name *Ceratocombus panamensis* Champion[7] applies, a matter which can not be decided definitely without study of the type of that species.

*Holotype, allotype and paratype.*—Cat. No. 27573, U.S.N.M.

### CERATOCOMBUS (LEPTONANNUS) MINUTUS Uhler

*Ceratocombus minutus* UHLER, P. R., Proc. Zoöl. Soc. London, 1894 (March 6), pp. 196–197 [Grenada].

Uhler compared this species with *brasiliensis* Reuter in his original description but the species he had under that name is our *major.* His *minutus* is much more closely related to *latipennis* Uhler, and in venation, both agree well with the figure of the forewing of *Leptonannus biguttulus* Reuter, an African species. Uhler's two species are very similar in structure but may be separated by the difference in hairs on the dorsal surface of the second rostral segment as pointed out in the key. The ocelli in *minutus* are noticeably larger than in *latipennis*, and in fully winged specimens the vein emanating from apex of the discal cell of forewing is much shorter than the vein forming the upper margin of that cell while in *latipennis* it is of nearly the same length. In the original description Uhler gives the color as dull black but the numerous specimens before us from the type series are of various shades of castaneous; this would seem to indicate fading. Length, 1.5–1.75 mm.

Specimens examined: Balthazar, Grenada, St. Vincent, H. H. Smith; Cacao Trece Aguas, Guatemala, April 11, E. A. Schwarz and H. S. Barber. In connection with the original description it is stated that the specimens were collected from April to September.

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[6] Uhler, P. R., Proc. U. S. Nat. Mus., vol. 27, 1904, pp. 361–362 [Las Vegas Hot Springs, New Mexico].

[7] Biol. Centrali-Amer. Insecta. Rhynchota Heteroptera, vol. 2, p. 336, April, 1900., [Panama].

### CERATOCOMBUS (LEPTONANNUS) LATIPENNIS Uhler

*Ceratocombus latipennis* UHLER, P. R., Proc. U. S. Nat. Mus., vol. 27, 1904, p. 362. [New Mexico].

There are before us four specimens of this species. The type male is in fair condition, lacking the antennae and some of the legs; the allotype is without head, and the wings on one side. A female from the same locality identified as *brasiliensis* Reuter by Uhler, is in fair condition, and, like the allotype, is brachypterous. The type is macropterous and has the venation of the forewing as in figure 3. In this species also fading is evident. Uhler gives the body color as black, with the hemelytra testaceous; the type now is chocolate brown, with the fore wing stramineous. Length, 1.5 mm.

Four specimens (all damaged) from Las Vegas Hot Springs, New Mexico, August 8, 13, 17, E. A. Schwarz and H. S. Barber.

### Genus CRYPTOSTEMMA Herrich-Schäffer

*Cryptostemma* HERRICH-SCHÄFFER, G. A. W., in the continuation of Panzer, G. W. F., Faunae Insectorum Germanicae oder Deutschlands Insecten, No. 135, p. 11, 1835. [Monobasic, genotype *C. alienum*, new species, Germany.] We have been unable to verify this reference, but Dr. E. Bergroth confirms the date; Haliday thus was mistaken about the name being preoccupied by *Cryptostemma* Guerin (Arachnida) which was published in 1838.

*Dipsocoris* HALIDAY, A. H., Nat. Hist. Review, vol. 2, 1855, Proc. Soc. p. 61, pl. 2, fig. 3. [Monobasic, genotype, *Cryptostemma alienum* Herrich-Schäffer, Germany].

We have before us the genotype of *Cryptostemma;* the minute closed cell at the base of the discal cell of fore wing shown in our figure (9), is present in the genotype, though not indicated in Reuter's figure of that species. The beak is shorter and stouter in all the known species of this genus than it is in *Ceratocombus.*

#### KEY TO THE SPECIES

1. Discal and apical cells of fore wing separated by a longitudinal vein, that is, the apical cell pedunculate (fig. 8)____**pedunculatum**, new species.
Discal and apical cells of fore wing separated by a transverse vein, that is, the apical cell sessile (fig. 9)__________________________________ 2.
2. Second antennal segment distinctly less than twice as long as first; smaller species, 1 mm. in length__________________________**smithi**, new species.
Second antennal segment fully twice as long as first; larger species, 1.25–1.5 mm. in length________________ ______________________**uhleri**, new species.

### CRYPTOSTEMMA PEDUNCULATUM, new species

Head and thorax glistening lutescent, antennae and legs stramineous, fore wing dusky fumose, the surface polished and the long hairs on veins glistening. Venation of fore wing as in figure 8; left claspers of male as in figure 14. Length, 1 mm.

*Holotype.*—Bohio, Canal Zone, Feb. 7, 1911, E. A. Schwarz. Cat. No. 27574, U.S.N.M.

### CRYPTOSTEMMA SMITHI, new species

Body color rubiginous, fore wings dusky with lustrous surface and pubescence as in the other species. Length, 1 mm.

*Holotype and one paratype.*—Females, Grenada, H. H. Smith. Cat. No. 27575, U.S.N.M.

Named for the collector, an assiduous field entomologist who brought to light many rare and interesting insects.

### CRYPTOSTEMMA UHLERI, new species

General color lustrous lutescent to testaceous, fore wings slightly fumose to dusky. Venation of fore wing as in figure 9; hind wing as in figure 6. Length, 1.25–1.5 mm.

*Holotype.*—Female, Cordoba, Vera Cruz, Mexico, April 11, 1908, A. Fenyes; paratype, female, St. Vincent Island. (Uhler Coll.) Named for Dr. P. R. Uhler, who did so much indispensable pioneer study of American Hemiptera. Cat. No. 27576, U.S.N.M.

## Subfamily SCHIZOPTERINAE

The vestitute in this subfamily is much as in the Cryptostemmatinae except for the usual lack of distinct bristles. The genitalia have different, but no less notable characters; these are mentioned further in the keys and also are figured. Contrasting markings are more prevalent than in the other subfamily but so far as seen practically only gradations of black and white (sometimes cream) are present.

These minute insects have a wealth of structural characters and the prospects are that study of additional material will greatly increase the number of genera and species. Some of the characters do not seem to have the same significance attached to them in other families of Heteroptera. For instance ocelli may be present or absent in the same genus irrespective of whether the specimens are macropterous or not. The position of the head in most of the genera is decumbent, much as it is in Homoptera, but in one genus (*Nannocoris*) it is porrect; this is but one of the numerous intergradations between this subfamily and the Cryptostemmatinae.

### KEY TO THE GENERA

1. Propleurum not conspicuously swollen anteriorly, falling considerably short of attaining anterior margin of eyes in profile (fig. 15); venation of fore-wing as in figure 44_________________________Ceratocomboides, new genus.

Propleurum conspicuously swollen anteriorly, attaining or surpassing anterior margin of eyes (figs. 16–19)___________________________ 2

2. Metapleurum produced in the form of a prominent sharp spike at inner posterior angle (fig. 18); first costal cell of forewing larger than second, the vein bounding apical margin of latter joining costa almost at a right angle (fig. 49) __________ **Schizoptera Fieber.**

Metapleurum may be more or less produced but never with a pronounced spike at inner posterior angle; first costal cell in wings of normal shape, equal to or smaller than second, the vein bounding apical margin of latter joining costa obliquely (figs. 52–58) __________ 3

3. Forewings but slightly or not at all convex, not entirely heavily coriaceous, normally formed, or the costal margin very conspicuously explanate (figs. 52–53, 55–56); claval suture present __________ 4

Forewings strongly convex, entirely coriaceous, with sometimes a very narrow thinner strip along inner apical margin; claval suture obsolete or almost indistinguishable; habitus beetle-like; tibiae with much stronger setulae than in contrasted group __________ 7

4. Pronotum without a transverse impressed line near anterior margin; first and second costal cells about equal in length, separated by a short straight vein at right angles to costal vein (figs. 53, 55). (See also notes on *Oncerodes* Uhler, p. 32) __________ 5

Pronotum with a very distinct transverse impressed line near anterior margin; first and second costal cells measured along costa very unequal in length (figs. 52, 56) __________ 6

5. Pronotum not at all produced backward, scutellum exposed **Corixidea Reuter.**

Pronotum angularly produced in center posteriorly so as to conceal the scutellum (fig. 20) __________ **Membracioides, new genus.**

6. Costal margin of forewing remarkably explanate, viewed from below the explanate portion is over half as wide as venter of abdomen, habitus as in figure 21; first costal cell of wing much shorter than second, separated from it by a straight vein which joins costa at a right angle (fig. 52); head depressed in front as usual in the family __________ **Tropistotrochus Reuter.**

Costal margin of fore wing more or less reflexed but not explanate; first and second costal cells of wing about equal in area but the separating vein is oblique so that the first cell is longer along hind margin of costal vein than is the second (fig. 56); head more or less conically produced (figs. 22–25) __________ **Nannocoris Reuter.**

7. Eye small to medium in size, its width distinctly less than interocular space, overlapping not more than a third of lateral pronotal margin; reflexed costa percurrent __________ 8

Eye large, as wide as interocular space, overlapping two-thirds of lateral pronotal margin; reflexed portion of costa evanescent before middle of forewing __________ 9

8. Pronotum without a transverse impressed line near anterior margin; venation obvious; eye about one half as wide as interocular space (fig. 26) __________ **Hoplonannus, new genus.**

Pronotum with a transverse impressed line near anterior margin, forewing entirely closely reticulate, venation almost obsolete; eye about one-third as wide as interocular space (fig. 27) __________ **Ptenidiophyes Reuter.**

9. Venation traceable; forewing with a depressed area bordering entire sutural margin; that is fitted for overlapping. (fig. 28) (See also notes under *Ommatides* Uhler, p. 33) __________ **Glyptocombus Heidemann.**

Forewing closely punctured throughout, venation obsolete, without depressed area along sutural margin, the latter nearly straight (fig. 30) **Hypselosoma Reuter.**

### CERATOCOMBOIDES, new genus

This genus is distinctly intermediate between the Cryptostemmatinae and the bulk of the Schizopterinae. However, it is more strongly allied to the latter group by the shape of head, lack of costal fracture, and by the venation. The latter is much as in macropterous species of the genus *Schizoptera* (fig. 44), but the veins are about equally, though moderately, elevated throughout, the radius being no more conspicuously raised than the others. The pronotum has a distinct impressed line near anterior margin; the eyes are higher than long (fig. 15); and ocelli are present. The abdomen of male has 6 visible ventral segments.

*Genotype.—Ceratocomboides prima.*

#### CERATOCOMBOIDES PRIMA, new species

*Male.*—Yellowish-brown, slightly shining, the legs stramineous. Dorsum of head, pronotum, and veins of corium with pale decumbent hairs. Space between eyes at vertex about 3 times as wide as either eye; head broadly rounded in front when seen from above; ocelli rather large; head and thorax from side as in figure 15. Impressed transverse line on pronotum slightly convex posteriorly; hind margin of pronotum a little concave; apex of scutellum somewhat produced but not visibly notched; thorax more depressed than in other genera, the pleura nearly horizontal. Hypopygium with a long curled process as in *Schizoptera*, but the hypopygium is clearly visible from below; 5th sternite longer than hypopygium. Venation of forewing as in figure 44. Length, 0.75 mm.

*Holotype.*—Porto Bello, Panama, March 11, 1911, E. A. Schwarz. Cat. No. 27577, U.S.N.M.

### Genus SCHIZOPTERA Fieber

*Schizoptera* FIEBER, F. X., Wien. Ent. Monatschr., vol. 4, no. 9, Sept., 1860, pp. 268–269. [Monobasic, *S. cicadina*, new species, Venezuela, p. 272.]

Reuter divided the genus *Schizoptera* into three subgenera,[8] later[9] proposing generic rank for one of them, *Corixidea*. We treat all of his segregates as genera and further subdivide the genus *Schizoptera*, as thus restricted, into seven subgenera as indicated in the following key.

#### KEY TO THE SUBGENERA AND SPECIES

1. Pronotum without a transverse impressed line near anterior margin; suture between pronotum and propleurum running almost straight backward to hind margin, not obliquely from lower hind margin of eye to humerus, hind margin of propleurum without a short angular projection above near

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[8] Monograph, 1891, pp. 17–18.

[9] Hemip. Miscell., 1912, pp. 65–66.

suture (fig. 18); ocelli present; some of the lateral cephalic hairs very long. Subgenus *Orthorhagus*, new subgenus, subgenotype, *S. plana*, new species------------------------------------------ **plana**, new species.

Pronotum with a distinct curved or subangular transverse impressed line near anterior margin (figs. 34, 35)------------------------------ 2

2. Suture between pronotum and propleurum as in *Orthorhagus* (last section), but the propleurum with an angular process or projection near suture on its hind margin (fig. 16)---------------------------- 3

Suture between pronotum and propleurum running obliquely from behind lower margin of eye to humerus, propleurum without a process on its hind margin near suture (fig. 17)------------------------------- 10

3. Ocelli present; scutellum spatulate apically (fig. 41). Subgenus *Kophaegis*. new subgenus, subgenotype *S. cubensis*, new species--------------- 9

Ocelli lacking; scutellum not spatulate apically. Subgenus *Odontorhagus*, new subgenus, subgenotype *S. bipartita*, new species--------------- 4

4. Hairs on pronotum erect and quite conspicuous, especially anteriorly, equaling or exceeding in length the second antennal segment, those on veins of corium much longer than the height of the veins above field of wing; fifth abdominal segment of male as in figure 60; membrane of fore wing brown from second apical vein to costa, cream-colored from second apical vein to hind margin------------------- **bipartita**, new species.

Hairs on pronotum depressed, much shorter than second antennal segment, those on veins of corium not longer than height of veins above field of wing; membrane of fore wing not bipartite in color as above------- 5

5. A large fuscous spot covering apical half of membrane of fore wing, its proximal outline rounded; femora darker than tibiae; fifth sternite of male as in figure 61-------------------------------- **repetita**, new species.

Membrane of fore wing without a large fuscous apical spot; femora not darker than tibiae--------------------------------------------------- 6

6. Space between eyes on vertex as wide as or wider than one eye--------- 7

Space between eyes on vertex not as wide as one eye------------------ 8

7. Fifth sternite of male with a large thumblike process on left side at base (fig. 62)------------------------------------------- **clodius**, new species.

Fifth sternite of male without process (fig. 63)----------- **decius**, new species.

8. Fifth sternite of male with a long sharp process at base (fig. 64) **commodus**, new species.

Fifth sternite of male with a short obtuse process at base (fig. 65) **drusus**, new species.

9. The black color of fore wing not continued along costa beyond outer transverse vein between radius and costa (fig. 45); legs entirely yellow **cubensis**, new species.

The black color of fore wing continued in a wedge-shaped mark along costa beyond outer transverse vein; coxae and femora largely dark brown **similis**, new species.

10. Ocelli absent---------------------------------------------------- 11

Ocelli present--------------------------------------------------- 16

11. Fore wings not highly convex, the apical part membranous; outer two veins of membrane fusing about a third of their length from apex of wing (fig. 46); metapleurum without cross ridge, fifth sternite of male as in figure 67. Subgenus *Zygophleps*, new subgenus, subgenotype, *S. unica*, new species------------------------------------------ **unica**, new species.

Fore wings entirely coriaceous and highly convex, metapleurum with cross ridge (fig. 36). Subgenus *Cantharocoris*, new subgenus, subgenotype, *S. reuteri*, new species---------------------------------------- 12

12. Pronotum and fore wings with dense fine erect hairs which exceed in length the second antennal segment, those on forewings on entire surface; cross ridge of metapleurum near middle__________**reuteri**, new species.

Pronotum and fore wings with short inconspicuous hairs which are much shorter than second antennal segment, those on fore wings confined to veins; cross ridge of metapleurum near lateral margin (fig. 36)___ 13

13. Veins of fore wing only slightly raised, radius distinctly elevated only at base; clavus outlined by rather deep and slightly irregular impressed lines; no closed cells evident; apical sternite of female as in figure 66
**scymnus**, new species.

Veins of fore wing distinctly elevated, or at least the radius moderately or conspicuously so for its entire length________________________ 14

14. Clavus short, its sutural margin only about twice as long as scutellum; a well-marked closed cell beyond apex of clavus (fig. 50)
**elmis**, new species.

Clavus long, its sutural margin more than three times as long as scutellum; closed cell either indistinct or absent______________________ 15

15. A distinct cross vein in fore wing near apex of clavus, that is closed cell indicated (fig. 51)________________________________**uhleri**, new species

No cross vein in fore wing near apex of clavus____________**reitteri** Reuter.

16. Metapleurum with a feeble, and only slightly curved cross ridge or none (fig. 37) (Subgenus *Schizoptera*, subgenotype *S. cicadina* Fieber)____ 17

Metapleurum with a distinctly elevated, strongly curved cross ridge, paralleled laterally and posteriorly by an impressed line (fig. 39) (Subgenus *Lophopleurum*, new subgenus, subgenotype *S. sulcata*, new species)__ 28

17. Metapleurum lacking cross ridge (fig. 37)______________________ 18

Metapleurum with a cross ridge (in some cases the light must be at a certain angle to reveal it), the inner portion of the sclerite sometimes elevated______________________________________________ 23

18. Pronotum with an areolate appearance (under magnification) like pebbled leather, the areoles (more reflecting than lines between them) fully equal in diameter to third antennal segment; hairs on pronotum long and erect, at least as long as second antennal segment, the cell between costa and radius with hairs and areolation on almost its entire surface; fifth sternite of male as in figure 68_____________**reticulata**, new species.

Pronotum not areolate as in last species___________________________ 19

19. Hairs on upper part of frons and anteriorly on pronotum erect, and like those on corium about as long as second antennal segment; fifth sternite of male as in figure 69________________________________**hirta**, new species.

Hairs on upper part of frons and on pronotum more decumbent, and like those on corium much shorter than second antennal segment______ 20

20. Fifth sternite of male about as long as remainder of abdomen, acutely pointed posteriorly (fig. 70)______________________**caudata**, new species.

Fifth sternite of male much shorter than remainder of abdomen______ 21

21. Femora dark, corium entirely dark, base of membrane broadly darkened; fifth sternite of male as in figure 71_____________**mexicana**, new species.

Femora pale, corium with pale edgings, base of membrane narrowly darkened_____________________________________________ 22

22. Eye less than half as wide as vertex; fifth sternite of male as in figure 72
**paraguayana**, new species.

Eye more than half as wide as vertex; fifth sternite of male as in figure 73
**affinis** Poppius.

23. Hairs on pronotum and corium erect and long, most of them longer than second antennal segment, the cell between radius and costa nearly all haired; fifth sternite of male with a compressed chitinized process which is directed backward (fig. 74)____________________**pilosa**, new species.
Hairs on pronotum and corium much less conspicuous than in last species, decumbent, their length not equal to that of second antennal segment; fifth sternite of male not as above______________________________ 24
24. Coxae and femora almost entirely black; cross ridge of metapleurum nearer outer than inner margin of the sclerite__________________________ 25
Coxae and femora yellow_____________________________________________ 26
25. Anterior cross vein almost at apex of discal cell, usually close to posterior cross vein; scutellum with two depressed shining spots: fifth sternite of male as in figure 75_________________________________**apicalis** Reuter.
Anterior cross vein at about one-third from apex of discal cell, well separated from posterior cross vein; scutellum without depressions; fifth sternite of male as in figure 76_____________________________**nigrita**, new species.
26. Apex of membrane of forewing with a large fuscous spot; fifth sternite of male as in figure 77______________________**apicipunctata**, new species.
Apex of membrane of forewing without a fuscous spot_______________ 27
27. Fifth sternite of male as in figure 78________________**vitellius**, new species.
Fifth sternite of male as in figure 79________________**licinius**, new species.
28. Fifth sternite of male with one short backwardly directed process near apex on left side (fig. 80)________________________**sulcata**, new species.
Fifth sternite of male with two processes on left side_______________ 29
29. Hind process on side of fifth sternite of male directed backward (fig. 81). **bispina**, new species.
Hind process on side of fifth sternite of male directed to the side (fig. 82). **tenuispina**, new species.

### SCHIZOPTERA (ORTHORHAGUS) PLANA, new species

*Male.*—Opaque brownish black, the legs but little paler; membrane of forewing largely cream colored, narrowly blackish at base and fuscous at apex (fig. 49). Eye nearly half as wide as interocular space; two long erect fine hairs on each side of face close to eyes and anterior to ocelli, the other frontal hairs rather long, but decumbent and like those on pronotum and veins of corium, with golden reflections; pronotum slightly narrowed anteriorly, humeri convex; pleura as in figure 18; hind margin of pronotum convex each side of the middle, the sides meeting in a shallowly angulate emargination; scutellum tumid, with no evident preapical notches; metapleurum reticulate and dull except on extreme inner margin; venation of forewing as in figure 49; fifth sternite as in figure 59. Length, 1 mm.

*Holotype.*—Cacao Trece Aguas, Alta Vera Paz, Guatemala, April 11, E. A. Schwarz and H. S. Barber. Cat. No. 27578, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) BIPARTITA, new species

*Male.*—Fuscous, paler below; legs stramineous, membrane from second vein to hind margin much paler than anterior half. Eye about as wide as interocular space. Frons, pronotum, and wing veins with erect hairs which are much longer than usual, many of them equal to or exceeding length of second antennal segment. Transverse impressed line on pronotum deep, curved, its distance from anterior margin at middle nearly as great as length of eye as seen from above. Pronotum shallowly emarginate in front of base of scutellum, the latter with subapical notches; metapleurum of about same texture throughout, reticulate but moderately shining; fifth abdominal sternite as in figure 60.

*Female.*—Similar to male, but the frons is much wider than one eye (1.75:1). Length, 1–1.2 mm.

*Holotype.*—Male, and 2 paratype males, Livingston, Guatemala, May 12 and 11 respectively: allotype and 1 female paratype, Cacao Trece Aguas, Alta Vera Paz, Guatemala, April 4 and 21, E. A. Schwarz and H. S. Barber. Cat. No. 27579, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) REPETITA, new species

*Male.*—Differs from *bipartita* in having the base of membrane of forewing pale yellow, and the apex with a large dark spot which is rounded on its proximal side, and the femora brown, or fuscous. The frons is nearly twice as wide as one eye, and the pronotum and wing veins have the hairs short and decumbent. Pronotum shallowly emarginate in front of base of scutellum, apex of latter somewhat acuminate but scarcely notched; metapleurum as in *bipartita;* head and thorax from above as in figure 34; fifth abdominal sternite is as in figure 61.

*Female.*—Similar to the male in color. The hairs on dorsum are as in male. Length, 1.25 mm.

*Holotype.*—Male, allotype, 2 other males and 1 female, Livingston, Guatemala, 3 males and 2 females, May 4, 5, 9, 11; Cacao Trece Aguas, Alta Vera Paz, Guatemala, 1 male, April 18, E. A. Schwarz and H. S. Barber; Tampico, Mexico, 2 females, December 14, E. A. Schwarz. Cat. No. 27580, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) CLODIUS, new species

*Male.*—Differs from preceding species in having the entire membrane pale yellow, and the legs including the coxae stramineous. The frons is not over 1.25 as wide as one eye, and the dorsal hairs are very short and decumbent. Fifth abdominal sternite as in figure 62. Pronotum shallowly emarginate in front of base of scutellum, the latter with subapical notches; metapleurum as in preceding two species. Length, 1.25 mm.

*Holotype.*—Paraiso. Canal Zone, Panama, February, 1911, E. A. Schwarz. Cat. No. 27581, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) DECIUS, new species

*Male.*—Similar in color and structure, including metapleural surface, pronotal emargination, and scutellar notches, to the preceding species. Differs essentially in the structure of the fifth sternite as shown in figure 63. Length, 1.25 mm.

*Holotype.*—Gatun, Canal Zone, Panama, April 7, 1911, E. A. Schwarz; paratype male, Cabima, Panama, May 22, 1911, A. Busck. Cat. No. 27582, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) COMMODUS, new species

*Male.*—Similar to preceding two species in color and structure. The frons is a little narrower than one eye, and the fifth abdominal sternite is as shown in figure 64. Length, 1.25 mm.

*Holotype.*—Livingston, Guatemala, May 9, E. A. Schwarz and H. S. Barber. Cat. No. 27583, U.S.N.M.

### SCHIZOPTERA (ODONTORHAGUS) DRUSUS, new species

*Male.*—Similar in color and structure to the preceding species. Differs in having pronotal emargination more of an angulate type formed by the junction of the slightly convex halves of the hind margin and in having the fifth sternite as in figure 65. Pleura as in figure 16. Length, 1.5 mm.

*Holotype.*—Cacao Trece Aguas, Alta Vera Paz, Guatemala, March 30, E. A. Schwarz and H. S. Barber. Cat. No. 27584. U.S.N.M.

### SCHIZOPTERA (KOPHAEGIS) CUBENSIS, new species

*Female.*—Black, subopaque; anterior and lower parts of head, legs, and antennae basally, yellow, the apex of scutellum brownish or yellowish; fore wings marked as in figure 45. Ocelli quite conspicuous; distance between eyes at vertex distinctly over twice as wide as one eye. Dorsum of head, pronotum, and veins of corium with microscopic decumbent pale hairs. Suture between pronotum and propleurum as in figure 16, the angular projection on hind margin of latter distinct; pronotum rather inflated behind, distinctly elevated above scutellum and fore wings, almost transverse posteriorly, having no distinct emargination; scutellum broadly rounded, spatulate beyond subapical notches (fig. 41). Vein closing fore part of discal cell of fore wing sloped but little backward, the first transverse vein between radius and costa at or close to middle of discal cell (fig. 45). Metapleurum reticulate, moderately shining. Length, 1.5 mm.

*Holotype.*—Also 1 paratype, Cayamas, Cuba, May 20 and 11, respectively, E. A. Schwarz. Cat. No. 27585, U.S.N.M.

### SCHIZOPTERA (KOPHAEGIS) SIMILIS, new species

*Female.*—Differs from the foregoing in having the pronotum less inflated, and the coxae, the greater part of femora, and bases of fore and mid tibiae dark brown, and a wedge-shaped prolongation of black along costa beyond the outer transverse vein. Length, 1.5 mm.

*Holotype.*—Also 1 paratype,, Cayamas, Cuba, March 5 and 6, E. A. Schwarz. Cat. No. 27586, U.S.N.M.

### SCHIZOPTERA (ZYGOPHLEPS) UNICA, new species

*Male.*—Brownish fuscous, legs, antennae, costa, and membrane in part, yellow. Hind margin of pronotum with a broad, shallow, median, and two narrower lateral emarginations, scutellum very slightly notched subapically. The frons is about 1.75 as wide as one eye, the transverse impressed line near anterior margin of pronotum is slightly curved, the hairs on pronotum and fore wings are short and subdecumbent, and the first cross vein of fore wing is about two-fifths from apex of discal cell; apex of wing as in figure 46. Fifth abdominal sternite as in figure 67. Length, 1.25 mm.

*Holotype.*—Livingston, Guatemala, May 7, E. A. Schwarz and H. S. Barber. Cat. No. 27587, U.S.N.M.

### SCHIZOPTERA (CANTHAROCORIS) REUTERI, new species

*Female.*—Reddish brown to brownish black, subopaque. Head at base of beak, the antennae chiefly, and the legs, yellowish; apex of fifth sternite and apices of wings brownish yellow. Head quite convex between eyes when seen from above, either eye about one-third as wide as space between them; ocelli absent. Hairs of head, pronotum, and fore wings denser and longer than usual in the genus, erect, practically the entire upper surface of the fore wings hairy. Propleurum projecting a little beyond anterior margins of eyes when seen from above, without a process on hind margin, the suture between propleurum and pronotum extending obliquely from lower angle of eye to humerus; metapleurum reticulate, with a low ridge across middle, the inner half more strongly shining than outer. Pronotum distinctly, though shallowly emarginate in front of scutellum, the latter depressed, acuminate, slightly notched subapically. Apical sternite a little longer than the preceding two combined. Fore wings highly convex, costa reflexed to apex, but gradually narrowed from base, a broad depression along inner margin of marginal vein of clavus, a deep linear one along the claval suture, and the principal vein of corium noticeably elevated, other venational details almost obliterated; commissure nearly straight, the hemelytra but little overlapping. Hind tibia straight, without obvious erect ventral hairs. Length, 1.25 mm.

*Holotype.*—Polochic River, Guatemala, May 2, H. S. Barber; three paratype females, Livingston, Guatemala, May 8, 10, E. A. Schwarz and H. S. Barber. Cat. No. 27588, U.S.N.M.

### SCHIZOPTERA (CANTHAROCORIS) UHLERI, new species

Similar in color to preceding species but the base of beak and the legs are paler, and the apices of fore wings are yellowish. Habitus as in *S. reuteri* but the insect differs in being much shorter haired, in having the cross ridge of metapleurum near lateral margin, most of that sclerite being distinctly shining, and the venation of fore wing more like that of normal species of the genus, though on the declivitous apical portion the veins are almost obsolete and at the extreme apex are entirely so. Pronotum slightly emarginate medianly, the scutellum abruptly narrowed at apex but scarcely notched. Hind tibia slightly bent and with long ventral hairs. Pleura as in figures 17 and 36; base of fore wing as in figure 51. Length, 1 mm. Grenada, H. H. Smith, two females.

*Holotype and paratype.*—Cat. No. 27589, U.S.N.M.

Recorded as *Ptenidiophyes mirabilis* Reuter, by Uhler in his paper on the Hemiptera of Grenada.

### SCHIZOPTERA (CANTHAROCORIS) REITTERI Reuter

*Schizoptera* (*Sch*[*izoptera*]) *reitteri* REUTER, O. M., Monograph, 1891, p. 22 [Brazil].

Fuscous, the margins and veins pale brownish, the antennae and legs testaceous. Form of pronotum and scutellum as in *uhleri*; metapleurum and genitalia concealed by mount. Length, 1 mm.

Specimen labeled " Spec. type No. 3924, Mus. Helsingfors." Blumenau. In original description this specimen is said to be from Brazil.

### SCHIZOPTERA (CANTHAROCORIS) ELMIS, new species

General color black, antennae basally, and legs testaceous, hind margin of pronotum, commissure, and costa brownish; pubescence short; form ovate, broadest behind middle; vertex more than twice as wide as one eye; scutellum shallowly and broadly emarginate in front of scutellum, the latter with subapical notches; commissure curved behind scutellum. Base of fore wing as in figure 50. Length, 1.5 mm.

*Holotype.*—Caracas, June 17, 1891, Meinert. Labelled "*Sch. flavipes* f. brach. Reut. Spec. typ. No. 3997, Mus. Helsingfors." However, this specimen can not be from the type material as *flavipes* was described in 1882; furthermore, Brazil is the only locality given even in the Monograph, 1891.

### SCHIZOPTERA (CANTHAROCORIS) SCYMNUS, new species

*Schizoptera* (*Schizoptera*) *apicalis* forma brachytera REUTER, O. M., Monograph, 1891, pp. 21–22 [Venezuela].

*Female.*—Form ovate, pronotum somewhat inflated posteriorly; vertex about twice as wide as one eye. General color fuscous, commissure testaceous, especially posteriorly, tibiae pale. Fifth sternite as in figure 66. Fore wing as in figure 48. Length, 1.25 mm.

*Holotype.*—Colonia Tovar, Venezuela, November 1, 1888, E. Simon. "Spec. typ. No. 3922, Mus. Helsingfors."

### SCHIZOPTERA (SCHIZOPTERA) RETICULATA, new species

*Male.*—Black, membrane of fore wings fuscous, the flap sometimes whitish; antennae and legs yellow, the femora more or less tinged with brownish. Frons over three times as wide as one eye. Pronotum with a distinct impressed transverse line which is only slightly curved; hind margin very slightly emarginate, the scutellum narrowed but scarcely notched subapically. Metapleurum reticulate, the extreme inner margin and spine pale and more shining. Hairs on frons, pronotum and corium longer than second antennal segment, and erect, the disk of corium as well as the raised veins haired. Dorsum of head and the pronotum areolate (as described in key), most distinctly so on latter. Venation of fore wings normal, the veins more elevated than usual in the genus. Fifth sternite as in figure 68. Length, 1.5 mm.

*Holotype.*—Also three paratypes, Livingston, Guatemala, May 8, 4, and 11, respectively, E. A. Schwarz and H. S. Barber; one paratype, Tampico, Mexico, December 29, E. A. Schwarz. Cat. No. 27590, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) HIRTA, new species

*Male.*—Differs in color from preceding species in having the membrane of fore wings pale yellow, with a large apical fuscous spot which is rounded on its anterior margin, and the legs yellow. The frons in male is about twice as wide as one eye, the dorsal hairs are shorter, the pronotum is not areolate; metapleurum as in last species, scarcely paler within; dorsal view of abdomen as in figure 83; and fifth sternite as figure 69. Hind margin of pronotum slightly emarginate medianly, the scutellum with small subapical notches. Metapleurum as in figure 37; hind wing as in figure 47.

*Female.*—Frons about three times as wide as one eye. In other respects like male. Length, 1.5–1.75 mm.

*Holotype.*—Male and allotype (on same mount), and 3 male paratypes, Trece Aguas, Alta Vera Paz, Guatemala, April 4, 18, March

28, 30; one male paratype, Livingston, Guatemala, May 4, E. A. Schwarz and H. S. Barber; four females from Panama also appear to belong to this species; two from Paraiso, April 30, 1911, one from Bohio, February 7, 1911, and one from Portobello, February 21, 1911, E. A. Schwarz. Cat. No. 27591, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) CAUDATA, new species

*Male.*—Brownish black, hind margin of pronotum narrowly yellowish, costa, commissure, and membrane of fore wing also yellow, the latter with a large apical brownish spot, legs yellow, femora sometimes darker. Pilosity as in last two species but shorter. Frons nearly three times as wide as one eye. Dorsal hairs short and decumbent. Pronotum trisinuate posteriorly; the scutellum with small subapical notches; metapleurum reticulate, moderately shining, unicolorous. Fifth sternite longer than usual, acute and more or less curled apically (fig. 70).

*Female.*—Differs from the male in lacking yellow markings other than that covering most of membrane. Length, 1.5–1.75 mm.

*Holotype.*—Male, allotype, and one male paratype, Tampico, Mexico, December 15, 18, and 14, respectively, E. A. Schwarz. Cat. No. 27592, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) MEXICANA, new species

*Male.*—Blackish fuscous; hind margin of pronotum narrowly yellowish; membrane of fore wing whitish, the dark color of corium extending rather broadly over bases of the apical veins, the apex with a large brownish spot which is rounded anteriorly; femora mostly brown, tibiae brown except apices. Distance between eyes at vertex about 2.5 as great as one eye; hairs on frons a little longer than those on pronotum and veins of corium, the latter very short. Hind margin of pronotum slightly emarginate medianly, scutellum with minute subapical notches. Corium granulose; anterior cross-vein not over one-fifth from apex of discal cell. Metapleurum uniform in color and sculpture, rather dull. Fifth sternite as in figure 71. Length, 1.5 mm.

*Holotype.*—Tampico, Mexico, December, E. A. Schwarz. Cat. No. 27593, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) PARAGUAYANA, new species

*Male.*—Ground color more brownish than in *mexicana*, pronotum without yellow hind margin, corium with pale edgings, the dark color of corium extending posteriorly but little upon membrane, the latter without dark spot at apex; legs yellow; pubescence short and sparse. Distance between eyes at vertex about three times as wide as one eye. Pronotum slightly trisinuate posteriorly, scutellum with subapical notches; metapleurum broadly pale within, reticulate, but subshining. Anterior cross vein of forewing about one-third from apex of discal cell. Fifth sternite as in figure 72. Length, 1.5 mm.

*Holotype.*—San Bernardino, Paraguay, K. Fiebrig. Cat. No. 27594, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) AFFINIS Poppius

*Schizoptera* (s. str.) *affinis* POPPIUS, B., Öfv. Finska Vet. Soc. Förh., vol. 52, Afd. A, No. 1, 1909–10, pp. 11–12 [Venezuela].

*Male.*—Pubescence and general color an in *paraguayana*, the pronotum yellowish posteriorly. Distance between eyes at vertex less than twice as wide as one eye. Hind margin of pronotum, and scutellum as in *paraguayana;* metapleurum pale only along extreme inner margin, granular for the most part, dark; anterior cross vein about one-fifth from apex of discal cell. Fifth sternite as in figure 73. Length, 1.5 mm.

Caracas, Venezuela, October 6, 1891, Meinert. Part of the type material. (Mus. Helsingfors.)

### SCHIZOPTERA (SCHIZOPTERA) PILOSA, new species

*Male.*—Fuscous, the dark color of corium extending a little over base of membrane, part of latter exterior to the apical veins yellowish, the flap whitish; legs yellow. Frons at vertex a little over twice as wide as one eye, dorsum of head, pronotum, and corium with rather dense erect hairs, most of which are longer than the second antennal segment, the hairs on costal portion of corium extending over disk, not confined to veins; inner cross vein about one-fourth from apex of discal cell. Pronotum with pronounced rounded emargination in front of scutellum, the latter with subapical notches; metapleurum reticulate, subshining, unicolorous, cross ridge about at middle. Fifth sternite as in figure 74. Length, 1.5 mm.

*Holotype.*—Livingston, Guatemala, May 6, E. A. Schwarz and H. S. Barber. Cat. No. 27595, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) APICALIS Reuter

*Sch.* [*izoptera*] *apicalis* REUTER, O. M., Rev. D'Ent, vol. 1, 1882, pp. 163–164 [Brazil].

*Male.*—Color much as in next species (*nigrita*) but membrane not infuscated apically. Otherwise much like *nigrita* except as noted in key. Fifth sternite as in figure 75. Length, 1.5 mm.

Colonia Tovar, Venezuela, November 1, E. Simon. Part of the monograph material labelled "Spec. typ. No. 3591 Mus. Helsingfors."

This specimen is of the typical form of *apicalis*, although the specific name seems more applicable to what Reuter designated as var. β. With little doubt this variety is really a distinct species. On page 20 we have described what Reuter regarded as the brachypterous form of *apicalis* as a valid species (*scymnus*, new species) and since Reuter mentions that he had several specimens, it is probable that other species can be distinguished in his *apicalis* material.

### SCHIZOPTERA (SCHIZOPTERA) NIGRITA, new species

*Male.*—Dead black, the membrane infuscated basally and apically, legs fuscous; head and pronotum with short decumbent pale hairs. Pronotum broadly but very shallowly emarginate in front of scutellum, the latter acuminate but not visibly notched apically. Metapleurum unicolorous, reticulate, the inner half more shining. Fifth sternite is as figure 76. Length, 1.5 mm.

*Holotype.*—Cordoba, Vera Cruz, Mexico, April 15, 1908, A. Fenyes. Cat. No. 27596, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) APICIPUNCTATA, new species

*Male.*—Fuscous, legs, antennae, hind margin of pronotum, costa, commissure, base and inner angle of corium, and membrane yellowish; the membrane narrowly infuscated at base, and with a large squarish sooty spot at apex. Head, pronotum, and veins of corium with decumbent hairs of moderate length. Hind margin of pronotum distinctly emarginate in front of scutellum, slightly sinuate each side; apex of scutellum narrowed but not perceptibly notched. Fifth sternite as in figure 77. Inner two-thirds of metapleurum elevated, but only the spine and its immediate base notably polished. Length, 1.5 mm.

*Holotype.*—Trece Aguas, Alta Vera Paz, Guatemala, April 5, E. A. Schwarz. Cat. No. 27597, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) LICINIUS, new species

Head, thorax, and corium pale fuscous, membrane whitish, slightly infuscate at base, and fumose on outer half; a smooth species, the only long hairs being a few on head, besides the usual vestiture of antennae. Pronotum slightly emarginate in front of scutellum, the latter scarcely notched subapically. Cross ridge of metapleurum about the middle, the inner half of the sclerite possibly more shining. Fifth sternite of male with a pronounced hook on left side as shown in figure 79. Length, 1.25 mm.

*Holotype.*—Male, Frijoles, Canal Zone, March 25, 1911, E. A. Schwarz. Cat. No. 27598, U.S.N.M.

### SCHIZOPTERA (SCHIZOPTERA) VITELLIUS, new species

Color about as in preceding species, the membrane less infuscate; vestiture the same except that hairs on veins are a little more prominent. Pronotum a little more emarginate in front of scutellum, the latter with slight subapical notches. Cross ridge of metapleurum at about the middle (fig. 38), surface of the sclerite about equally shining throughout. Fifth sternite of male with a more complex hook than in last species (see fig. 78). Length, 1 mm.

*Holotype.*—Male, Livingston, Guatemala, May 10, E. A. Schwarz and H. S. Barber. Cat. No. 27599, U.S.N.M.

### SCHIZOPTERA (LOPHOPLEURUM) SULCATA, new species

*Male.*—Brownish fuscous, pronotum unicolorous; membrane cream colored, with or without a faint darker tinge apically over tips of the veins; legs yellow. Dorsal hairs short and decumbent. Inner three-fourths of metapleurum elevated and polished, the elevated ridge paralleled within on outer and posterior sides by an impressed line (fig. 39). Pronotum slightly emarginate in front of scutellum, the latter narrowed and only slightly notched subapically (fig. 35). Fifth sternite with a more or less evident process on one side near apex (fig. 80). Length, 1.5 mm.

*Holotype.*—Also two paratypes, Grenada, West Indies, H. H. Smith; one male evidently the same species, Ancon, Canal Zone, May 12, 1911, at arc light, A. H. Jennings.

The Grenada specimens are from the Uhler collection and are labelled "*Schizoptera flavipes* Reuter" by Uhler. Cat. No. 27600, U.S.N.M.

### SCHIZOPTERA (LOPHOPLEURUM) BISPINA, new species

*Male.*—Similar to *sulcata* in pilosity and color but in the type the humeral angles are slightly yellowish, and there is a narrow extension of the dark color of the corium over base of membrane. Hind margin of pronotum slightly emarginate medianly, scutellum narrowed and only slightly notched apically. Metapleurum about the same as in *sulcata.* The principal differences in the shape of the fifth sternite as shown in figure 81. Length, 1.25 mm.

*Holotype.*—Cacao Trece Aguas, Alta Vera Paz, Guatemala, 1906, E. A. Schwarz and H. S. Barber.

A specimen from Tampico, Mexico, December 15, collected by E. A. Schwarz, has the lateral spines on fifth sternite much shorter but is apparently the same species. Cat. No. 27601, U. S. N.M.

### SCHIZOPTERA (LOPHOPLEURUM) TENUISPINA, new species

*Male.*—Pale fuscous, legs, antennae basally, costa, commissure, base of corium, and disk of membrane yellowish; hairs short, pale, sericeous. Pronotum shallowly emarginate in front of scutellum, the latter slightly notched apically. Metapleurum much as in preceding two species from which this form, however, differs strikingly in the armature of the fifth sternite (fig. 82). Length, 1.25 mm.

*Holotype.*—Gatun, Canal Zone, April 7, 1911, E. A. Schwarz. Cat. No. 27602, U. S. N. M.

## Genus CORIXIDEA Reuter

*Corixidea* Reuter, O. M., Monograph, 1891, pp. 17–18, fig. 14 [monobasic, genotype, *Schizoptera lunigera* Reuter, Brazil].

This genus (originally established by Reuter as a subgenus) differs from *Schizoptera* in the venation of fore wing as described in the key, and illustrated in figure 53, and the costa is merely rounded elevated, not explanate. The inner posterior angle of metapleurum is produced as a rounded lobe, not as a sharp spike, and the suture between propleurum and pronotum runs nearly straight back behind eye (fig. 19). Scutellum with the disk somewhat depressed and the margins slightly elevated, the apex narrowed. There is no impressed transverse line near anterior margin of pronotum in any of the species we have seen. The ocelli are minute.

### KEY TO THE SPECIES

1. Veins of the clavus greatly thickened, appearing as rounded ridges between which there is a deep depression about equal in width to either ridge; these thickened veins with conspicuously long hairs____crassa, new species.
   Veins of the clavus neither thickened nor long haired________________ 2.
2. Distance between eyes across back of head about twice the width of one of them; no conspicuous pale marking on fore wings——major, new species.
   Distance between eyes across back of head more than twice the width of one of them; a conspicuous thickly crescent-shaped pale marking on fore wings, the horns of the crescent near humeral angles_____lunigera Reuter.

### CORIXIDEA CRASSA, new species

*Male.*—Pronotum fuscous, head and posterior half of fore wings yellowish brown; fore wing with a whitish mark covering disk of clavus and the area between radial vein and clavus from base to apex of latter; antennae and legs yellowish. Frons at vertex fully three times as wide as one eye, with small symetrically arranged pale areas; basal two antennal segments subequal in length. Pronotum nearly twice as wide as long in center, hind margin regularly convex. Veins of clavus much elevated and thickened, rounded above, the space between them hardly widened apically and not greater than width of either vein. Hypopygium longer than preceding sternite. Length, 1.25 mm.

*Holotype.*—Also one paratype, Ancon, Canal Zone, May 12, 1911, at arc light, A. H. Jennings. Cat. No. 27603, U. S. N. M.

### CORIXIDEA MAJOR, new species

*Male.*—General color blackish, the heavily chitinized portions of upper surface with copious bluish-gray pubescence, that on head notably longer than in *lunigera* (no bare spots on head), more hyaline portions of forewing bluish cinereous; legs brownish testaceous. Head and pronotum from side as in figure 19; fore wing as in figure 53. Length, 1.25 mm.

*Holotype.*—Clarksville, Tenn., at light, August, 1915, G. A. Runner. S. E. Crumb No. 137. Mr. Crumb informs us that two specimens were collected, one on August 13 and the other on August 23. Apparently one has been lost. Cat. No. 27604, U.S.N.M.

### CORIXIDEA LUNIGERA Reuter

*Sch.* [*izoptera*] (*Corixidea*) *lunigera* REUTER, O. M., Monograph, 1891, pp. 24–25 [Brazil].

A specimen from Caracas, Venezuela, June 17, 1891, Meinert, determined as *lunigera* by Poppius we provisionally accept as representing that species. Considering the diversity of these little insects and the distance this specimen was taken from the type locality of *lunigera* it may well be a distinct species. Moreover, the specimen is in rather poor condition, especially as regards coloration. Evidently, however, it had a broad lunate pale marking over base of forewings as described for *lunigera* by Reuter. Blackish, a broad lunate cream-colored fascia on fore wings extending in middle from apex of scutellum to tip of clavus, anterior lateral prolongations reaching bases of fore wings near humeral angles; membrane whitish to fumose; legs and antennae testaceous. Pilosity pale, short, and depressed; a few pairs of longer hairs on lower part of face. Dorsum of abdomen as in figure 84. Length, 1.25 mm.

Other specimens of both sexes with the following data are assigned to this species. Trinidad Rio, Panama, June 9, 1912, A. Busck; Ancon, Canal Zone, at arc light, May 12, 1911, A. H. Jennings; Cacao Trece Aguas, Guatemala, July 13, E. A. Schwarz and H. S. Barber.

There are some differences in this series with respect to the small bare spots on head, but we find no other differential characters correlated with them. It may well be that there are distinct species in the *lunigera* group but we are unable to define any at present. Van Duzee has described *Schizoptera* (*Corixidea*) *doddsi*,[10] but the characters assigned do not separate it from *lunigera*. This has resulted chiefly from defects in Reuter's figure, which is very poor.

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[10] Proc. Pacific Coast Ent. Soc., vol. 2, pp. 33–34, Jan., 1924 [Mexico].

### MEMBRACIOIDES, new genus

Pronotum produced posteriorly in a median lobe which extends to middle of clavus thus entirely concealing the scutellum (fig. 20); the sides of the process are decidedly concave, and the apex moderately pointed; there is a distinct median impressed line from anterior margin of pronotum nearly to apex of the posterior prolongation. Suture between propleurum and pronotum running straight back behind eye; inner posterior angle of metapleurum produced as a rounded lobe; venation as in *Corixidea* (fig. 55). Apex of male abdomen from below as in figure 85.

*Genotype.—Membracioides parallela*, new species.

#### MEMBRACIOIDES PARALLELA, new species

*Male.*—Blackish, with a broad lunate cream-colored fascia over bases of forewings as in some species of *Corixidea;* a narrow band of same color (somewhat obscured medianly) across base of membranes, remainder of membranes fumose; legs chiefly testaceous. Pilosity of moderate length (longest on head), pale, decumbent. Symmetrically arranged denuded spots on head as in some *Corixidea* species; interocular width twice that of one eye. Male hypopygium from below as in figure 85. Length, 1.25 mm.

*Holotype.*—Cordoba, Vera Cruz, Mexico, April 27, 1908, A. Fenyes. Cat. No. 27605, U.S.N.M.

### Genus TROPISTOTROCHUS Reuter

*Tropistotrochus* REUTER, O. M., Monograph, 1891, pp. 15–16, fig. 9 [Monobasic, genotype *T. ampliatipennis*, new species, Brazil].

Costal margin of forewing remarkably explanate, the expanded portion when seen from below projecting beyond abdomen about as far as width of latter; venation highly characteristic (fig. 52). Head bluntly rounded both laterally and longitudinally; eyes small, nearly circular, ocelli relatively large, contiguous with upper anterior borders of eyes. There is a well developed pronotal collum depressed below disk, sides of pronotum constricted about middle; scutellum acuminate, elevated apically. Metapleurum truncate posteriorly. General habitus as in figure 21.

#### TROPISTOTROCHUS AMPLIATIPENNIS Reuter

*Tropistotrochus ampliatipennis* REUTER, O. M., Monograph, 1891, pp. 15–16, fig. 9 [Brazil].

Head and thorax brownish yellow, the legs and forewings paler; veins of latter and upper surface of thorax and head with moderately long pale hairs. The unique specimen is glued to a card so that the sex is not to be made out; the abdomen has four short and one (apical) long sternites. Length, 1 mm.

"Brazil, Blumenau, D. Reitter."

### Genus NANNOCORIS Reuter

*Nannocoris* REUTER, O. M., Monograph, 1891, p. 18, fig. 13. [Included species: *Sch.* [*izoptera*] *nebulifera*, new species, Bolivia, p. 23; and *Sch. tuberculifera*, pp. 23–24, fig. 13, Venezuela, of which the former was selected as genotype by Kirkaldy, '06, p. 148].

Remarkably distinguished in its subfamily by the shape of the head; instead of being short, broadly rounded, and bent downwardly and posteriorly as usual, the head in *Nannocoris* is conspicuously porrect, conical (figs. 22–25), with the beak arising from the anterior extremity; the beak is longer than in the other genera, reaching the hind coxae, the underside of head is grooved (fig. 33) and the sterna obviously troughlike for its reception. Pronotum with distinct collum. Pubescence short and decumbent, a little longer on anterior part of head. Other characters as noted in key. Venation illustrated in figure 56.

#### KEY TO THE SPECIES

1. Dorsum of head with a distinct elongate median tubercle (figs. 22–23) **tuberculifera** Reuter.
   Dorsum of head without tubercle 2
2. Vertex with a distinct median pit **cavifrons**, new species.
   Vertex without concavity 3
3. Head about four times as long as eye (fig. 24–25) **nasua**, new species.
   Head not more than three times as long as eye 4
4. Pronotum wholly dark; length of insect 1.25 mm **schwarzi**, new species.
   Pronotum pale margined posteriorly; length 1 mm. **flavomarginata**, new species.

### NANNOCORIS TUBERCULIFERA Reuter

*Sch.* [*izoptera*] (*Nannocoris*) *tuberculifera* REUTER, O. M., Monograph, 1891, pp. 23–24 [Venezuela].

Fuscous (orginally described as black), membrane, apex of head, top of tubercle, antennae, and legs pale yellow. The head is about two and one-half times as long as eye, somewhat abruptly narrowed in front of eyes and provided with an elongate median tubercle which is highest posteriorly (figs. 22–23). Venation of fore wing as in figure 56. Length, 1.25 mm.

*Holotype.*—Colonia Tovar, Venezuela, 1.11.88, E. Simon. (Mus. Helsingfors).

### NANNOCORIS CAVIFRONS, new species

*Male.*—Opaque brownish black, paler below; antennae, tibiae, and tarsi yellowish; a narrow pale yellow curved fascia across bases of membranes. Head from above almost equilaterally triangular, rather abruptly narrowed in front of eyes and projecting beyond eye about 1.5 as far as length of eye; frontal depression oval. Venation of fore wing similar to that of *N. tuberculifera* (fig. 56) but the inner cross vein with its inner extremity nearer to middle of the cell and more pronouncedly curved. Fifth sternite without a process on hind margin, slightly swollen on left side; hypopygium with ventral surface almost as long as fifth sternite. Length, 1.1 mm.

*Holotype.*—Cacao Trece Augas, Guatemala, April 25, E. A. Schwarz and H. S. Barber. Cat. No. 27606, U.S.N.M.

### NANNOCORIS NASUA, new species

*Female.*—Head tawny yellow, darker on vertex; thorax, corium, and abdomen blackish-brown; membrane broadly pale basally, blackish apically; beak, legs, and antennae yellow. Head regularly narrowed as seen from above, but contracted and upturned apically as seen from side, snoutlike (figs. 24–25); scutellum as in figure 42; fifth sternite as long as preceding three combined. Length, 1.5 mm.

*Holotype.*—Cacao Trece Aguas, Guatemala, April 19, E. A. Schwarz and H. S. Barber paratype same date except that date is April 18. Cat. No. 27607, U.S.N.M.

*Schizoptera capitata* Uhler is closely related to the above species according to sketches and notes kindly supplied by W. E. China of the British Museum. However, the head does not appear so narrowed anteriorly as viewed either from above or the side, and Mr. China reports that ocelli can not be made out.

### NANNOCORIS SCHWARZI, new species

*Male.*—Blackish-brown, the head in front of eyes, antennae, legs, and venter pale yellow, the costa whitish, and the membrane yellowish-hyaline. Head abruptly narrowed in front of eyes (fig. 32); fifth sternite emarginate medianly and on both sides, but more so on the right, hypopygium only narrowly exposed; cross-vein between anterior and intermediate costal cells very oblique but nearly straight. Length, 1.5 mm.

*Holotype.*—Porto Bello, Panama, March 12, 1911, E. A. Schwarz. Cat. No. 27608, U.S.N.M.

### NANNOCORIS FLAVOMARGINATA, new species

*Female.*—Brownish-black, head in front of eyes, and legs testaceous, hind margin of pronotum, costa, and membrane except a large rounded dusky apical spot yellowish. Head regularly narrowed from eyes to apex, the latter rather pointed. Head from below as in figure 19. Venation about as illustrated for *tuberculifera*. Length, 1 mm.

*Holotype.*—Paraiso, Canal Zone, April 11, 1911, E. A. Schwarz. Cat. No. 27609, U.S.N.M.

### HOPLONANNUS, new genus

In addition to the characters mentioned in the key, it should be stated that the head is well rounded both laterally and longitudinally; ocelli are lacking; pronotum lacks collum, is depressed, and the hind margin is distinctly concave (fig. 26); scutellum small, slightly swollen apically; fore wings with the veins traceable, their inner margins overlapping a little; propleurum much enlarged, extensively hollowed out for reception of the large fore coxae; head closely applied to these enlarged sclerites, the beak emerging distinctly between the coxae.

*Genotype*.—*Hoplonannus brunnea*, new species.

#### HOPLONANNUS BRUNNEA, new species

*Female*.—Opaque brown, apices of fore wings, antennae, and legs yellow. Dorsal aspect of head and pronotum as in figure 26, upper surface granular, with short decumbent pale hairs, those on front of head longer. Eye longer than high and not so high as propleurum below it. Scutellum shining and depressed at base. Length, 1 mm.

*Holotype*.—Cacao Trece Aguas, Guatemala, April 26, E. A. Schwarz and H. S. Barber. Cat. No. 27610, U.S.N.M.

### Genus PTENIDIOPHYES Reuter

*Ptenidiophyes* REUTER, O. M., Monograph 1891, p. 25, fig. 15. [Monobasic, genotype *P. mirabilis*, new species, Brazil, p. 26.]

In addition to the characters mentioned in the key we would state that the head is well rounded both laterally and longitudinally; the pronotum is depressed, its hind margin almost straight across; the scutellum moderately elevated throughout. Reuter's figure of the genotype shows two complete longitudinal lines on each fore wing which give the impression of veins, but the specimen has only the very slightest indication of one vein near the base; the costa is uniformly explanate throughout. The entire surface of the fore wings is covered with rather large punctures which are separated by about their own width. Ocelli lacking; the eyes do not extend backward along the sides of pronotum beyond the impressed line. General habitus as in figure 27.

#### PTENIDIOPHYES MIRABILIS Reuter

*Ptenidiophyes mirabilis* REUTER, O. M., Monograph, 1891, pp. 25–26, fig. 15 [Brazil].

General color opaque brown, darker anteriorly; legs, antennae, and costal margins stramineous. General habitus as in figure 27; dorsal surface with short, subdecumbent, pale hairs.

*Holotype.*—" Brazil, Blumenau, D. Reitter" (Mus. Helsingfors). The type is glued to a card so closely that genital and other ventral characters can not be seen. The specimens recorded from Grenada under this name by Uhler belong to the genus *Schizoptera* and are described under the specific name *uhleri* in this paper, page 19.

### Genus GLYPTOCOMBUS Heidemann[11]

*Glyptocombus saltator*, HEIDEMANN, OTTO, Proc. Ent. Soc. Wash., vol. 7, No. 4, pp. 192–194, fig. 21A, March 9, 1906 [Maryland].

Front nearly vertical, moderately convex between eyes; Ocelli minute, more removed (thrice their diameter) from eyes than in the other genera; pronotum with a distinct collum, and two large lateral callosities just behind it; scutellum depressed basally, elevated and rounded apically; ventral view of head as in figure 43; fore wings each with a depressed area along commissure so that they may overlap either way (fig. 28); venation as in figure 57; male with five distinct ventral segments, the apical one not so long as in the female; hypopygium reflexed on abdomen beneath the very convex forewings (fig. 29).

#### GLYPTOCOMBUS SALTATOR Heidemann

*Glyptocombus saltator*, HEIDEMANN, OTTO, Proc. Ent. Soc. Wash., vol. 7, No. 4, pp. 192–194, fig. 21A, March 9, 1906 [Maryland].

*Hypselosoma saltator* HORVATH, G., Ann. Mus. Nat. Hung., vol. 6, 1908, p. 565.

Black, with the legs, beak, and basal segments of antennae dusky yellow; entire dorsal surface with short, decumbent pale hairs; fore wings coarsely punctured between the veins. Dorsal and lateral views as in figures 28 and 29. Length, 1.2–1.5 mm.

*Holotype.*—Plummer Island, Md., October 4, 1905, D. H. Clemons; paratype same data, E. A. Schwarz; other specimens, same locality, September 29, 1905, D. H. Clemons; October 14, 1906, C. H. T. Townsend; District of Columbia, January or June, 1879, Theo. Pergande.

### Genus HYPSELOSOMA Reuter

*Hypselosoma* REUTER, O. M., Monograph, 1891, pp. 26–27, fig. 16 [Monobasic, genotype *H. oculata*, new species, New Caledonia].

Characters as mentioned in key; much like *Glyptocombus* in general appearance, but lacking ocelli, and prontal callosities; and with the scutellum more pointed. Dorsal view as in figure 30.

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[11] See remarks under *Ommatides* Uhler, p. 33.

### HYPSELOSOMA BOOPS, new species

*Female.*—Opaque black, legs and antennae tawny yellow, base of beak and knee joints brown; black portions with gray pruinescence, the venter with some gray hairs also; a seta near inner margin of eye, and several about base of beak; punctures in an area along commissure, beginning about a third from base of fore wings and running to apex, broadening posteriorly, coarser than elsewhere; length 1.2 mm. (fig. 30).

*Holotype.*—Spirit Valley, Nanking, Kiangsu Province, China, October 24, 1919, H. F. Loomis. Cat. No. 27611, U.S.N.M.

### NOTES ON UHLER'S GENERA IN THE BRITISH MUSEUM

W. E. China has very kindly sent us notes and sketches relative to two genera of Uhler the only known specimens of which are in the British Museum. We are thus enabled to give some points that may aid in identification of these forms. To further assist toward this end we quote the original descriptions.

### Genus ONCERODES Uhler

*Oncerodes* Uhler, P. R., Proc. Zool. Soc. Lond., pp. 159–160, Feb. 20, 1894 [Monobasic, genotype *O. robusta*, new species St. Vincent].

The original description is as follows:

### ONCERODES, gen. nov.

Coleopterine, and resembling an *Issus* in form; the hemelytra particularly wide and subglobose, blunt at the anterior end. Head nearly vertical, short and broad, moderately convex before the line of the eyes, transversely impressed between them; the cheeks separated by deep vertical lines, the tylus nearly linear; rostrum very short and thick, tapering at tip fitting very compactly into the sternum, reaching to tip of anterior coxae; antennae with the two basal joints thick, the second joint a little shorter and not so thick as the first, the remaining joints threadlike, finely pubescent. Pronotum transverse, nearly crescent shaped, moderately arched, having the anterior angles rounded off to fit the curve of the eyes. Scutellum acutely triangular, much longer than wide. Hemelytra but little longer than wide, suborbicular, narrower at base, corresponding to the width of the pronotum; the veins coarse and [p. 159] prominent, longitudinal, the two middle ones connected on the disk and sending back a branch parallel to the others, all of which continue out to the tip; suture of the clavus deeply defined, the clavus wide and nearly triangular. Legs stout, placed close together.

### ONCERODES ROBUSTA, sp. nov.

Short, thick, very convex, opaque bluish-black, with a velvety aspect above. Base of the hemelytra, including the scutellum, clavus, and a spot expanded on the costal margin, bright yellow. Head transversely rugulose, the front piceous, with the throat and antennae dull honey-yellow; the rostrum a little darker. Legs thick and short, honey-yellow. Venter dull black, rufo-piceous on the genital pieces.

Length to tip of hemelytra, 1¼ mm.; width of pronotum, ½ mm.; width of hemelytra, ¾ mm.

A single specimen was found on the leeward side of the island.

In respect to form of body and longitudinal direction of veins on the hemelytra this insect bears some relation to *Hypselosoma*, Reuter; but in all other respects it seems sufficiently different to constitute a separate genus [p. 160].

It is evident that *Oncerodes* is closely related to *Corixidea*, but the forewing is more coriaceous, the venation slightly different, the ocelli are indistinguishable in the type, and the scutellum is smaller than in *Corixidea*. It is possible that a brachypterous specimen of *Corixidea* might present some of the peculiarities of *Oncerodes*, but meantime it appears advisable to regard the latter as distinct pending the acquisition of more material. In none of the specimens of *Corixidea* examined by us is there any indication of an abbreviation of the fore wings. Head and thorax from above as in figure 40; fore wing as in figure 54. Redrawn from sketches by W. E. China.

## Genus OMMATIDES Uhler

*Ommatides* UHLER, P. R. Proc. Zool. Soc. Lond., p. 159, Feb. 20, 1894 [Monobasic, genotype *O. insignis*, new species, St. Vincent.]

The original description:

### OMMATIDES, gen. nov.

Coleopterine, closely resembling a short thick *Geocoris*. Eyes very large, oval, projecting diagonally against the anterior corner of the pronotum; front of the head short, bluntly tumid, with the face vertical, protracted downward, and having long lobate cheeks which converge over the base of the rostrum; antennæ filiform beyond the second joint, the basal joint shorter than and a little thicker than the second; rostrum thick at base, short, tapering, quite slender toward the tip, reaching almost to the middle coxae. Pronotum very short, almost annular, with the sides rounded off anteriorly to admit the form of the eyes, the posterior margin almost straight. The two forward pairs of legs placed near together; the anterior tibiae greatly thickened at tip and armed with long spines. Scutellum very short, transverse, triangular. Hemelytra high convex, extending amply over the abdomen and much longer than it; the costal border moderately curved, with the middle areole moderately wide, and the thick cubital vein running back parallel with the next inner vein all the way to tip of membrane, and with the two exterior transverse veins as in *Schizoptera*.

### OMMATIDES INSIGNIS, sp. nov.

Ovate, blunt, and wide in front; orange, with the pronotum, scutellum, and a broad band behind the scutellum, covering the membrane, blue-black. The head reddish brown above, yellow below the origin of the tylus, obsoletely scabrous, very minutely pubescent. Legs polished, stout, bright yellow, remotely hairy. Pronotum moderately arched, opaque, a little scabrous. Hemelytra thick, opaque, velvety; the membrane but little thinner than the corium, with the inner margin straight, not overlapping at tip, the apex a little tapering and rounded at tip.

Length to tip of membrane 1 millim.; width of pronotum ⅝ millim.

A single specimen of this peculiar little insect was taken, but no record is given concerning the place where it was found. [p. 159.]

This genus appears to be very close to *Glyptocombus* Heidemann. Without a careful comparison of specimens we do not care to commit ourselves further but there is a striking similarity in the general habitus and in the venation of the fore wings of these two genera. The head and thorax from above are shown in figure 31, and the fore wing in figure 58. Redrawn from sketches by W. E. China.

OTHER AMERICAN SPECIES NOT SEEN

| Name | Type locality | Further reference in this paper |
|---|---|---|
| | | *Page* |
| *Ceratocombus* (*Ceratocombus*) *bifenestratus* Poppius | Guadeloupe | 7, 35 |
| *Ceratocombus* (*Xylonanannus*) *boliviensis* Reuter | Bolivia | 4, 36 |
| *Ceratocombus panamensis* Champion | Panama | 8, 34 |
| *Schizoptera* (*Schizoptera*) *cicadina* Fieber | Venezuela | 12, 14, 35 |
| *Schizoptera* (*Schizoptera*) *flavipes* Reuter | Brazil | 19, 21 |
| *Schizoptera elegans* Poppius | Guadeloupe | 35 |
| *Schizoptera scutellata* Uhler | St. Vincent | 37 |
| *Corixidea doddsi* Van Duzee | Mexico | 26, 34 |
| *Nannocoris nebulifera* Reuter | Bolivia | 28, 36 |
| *Nannocoris capitata* Uhler | St. Vincent | 29, 37 |

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## EXPLANATION OF PLATES

### PLATE 1

FIG. 1. *Ceratocombus major*, fore wing.
2. *Ceratocombus vagans*, fore wing.
3. *Ceratocombus latipennis*, fore wing.
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FIG. 15. *Ceratocomboides prima*, head and prothorax from side.
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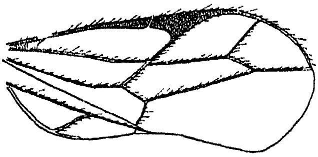

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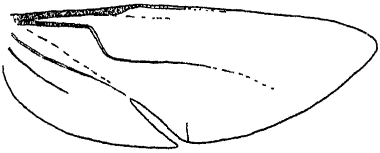

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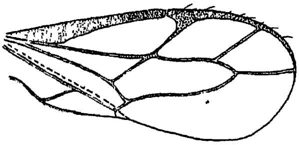

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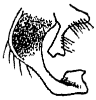

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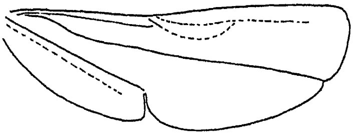

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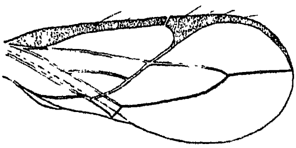

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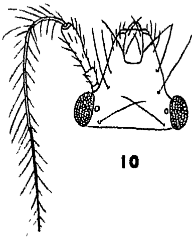

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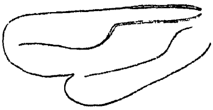

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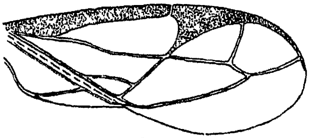

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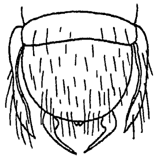

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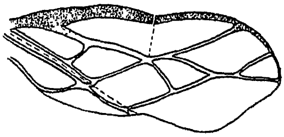

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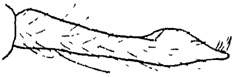

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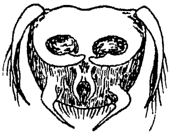

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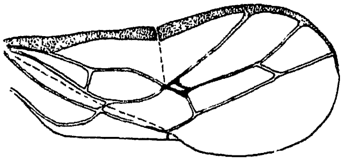

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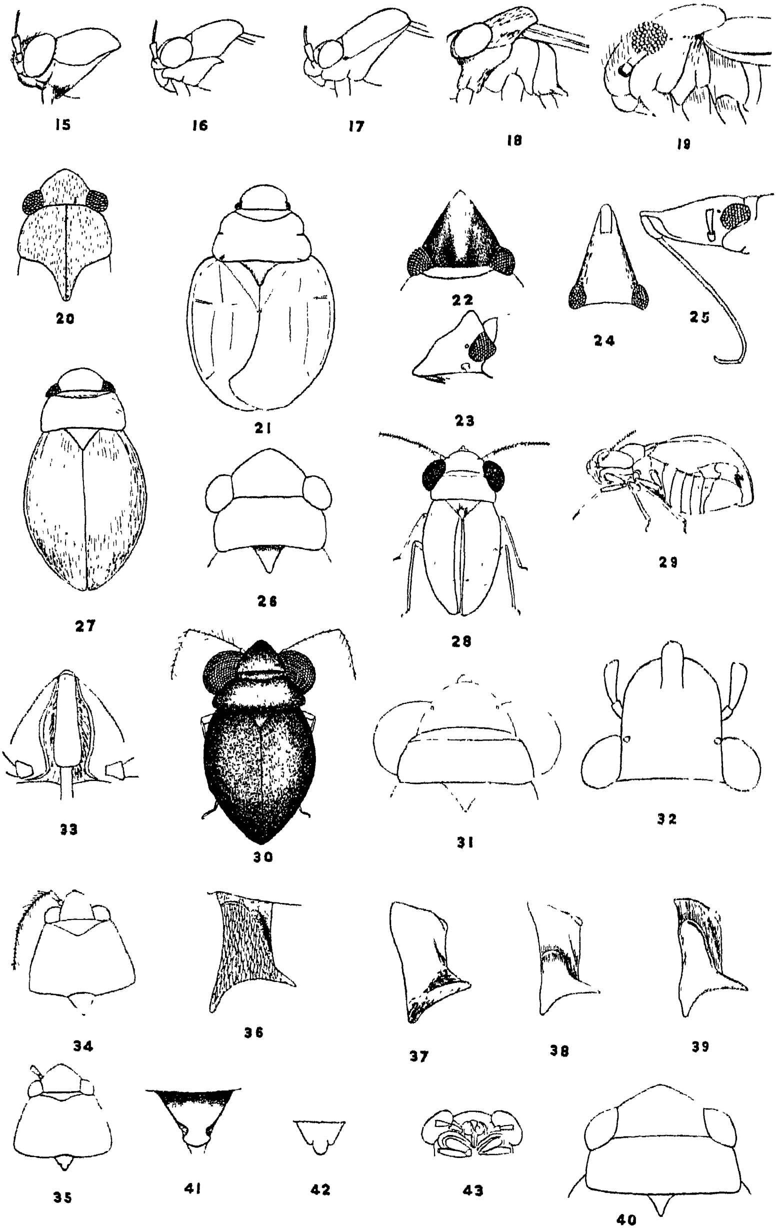
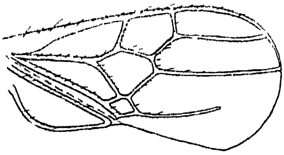
STRUCTURAL CHARACTERS OF CRYPTOSTEMMATINAE

FOR EXPLANATION OF PLATE SEE PAGE 37



STRUCTURAL CHARACTERS OF SCHIZOPTERINAE

FOR EXPLANATION OF PLATE SEE PAGE 38



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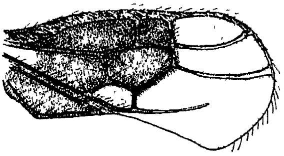

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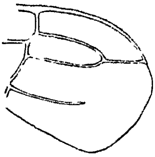

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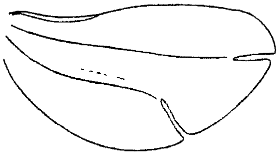

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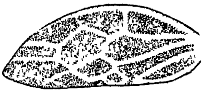

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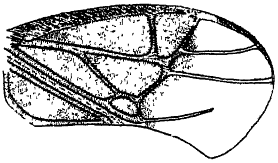

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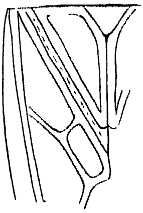

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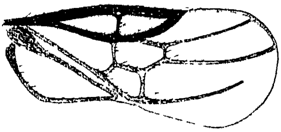

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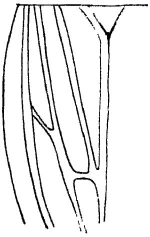

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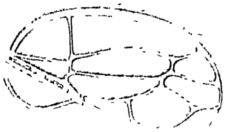

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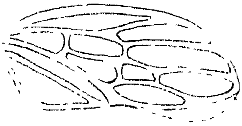

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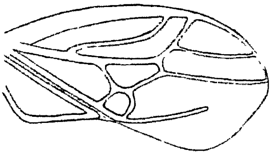

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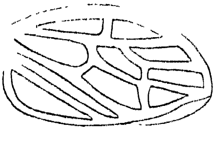

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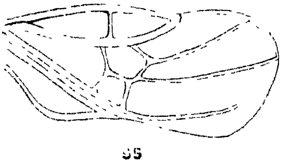

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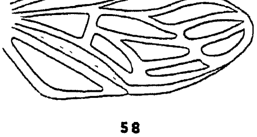

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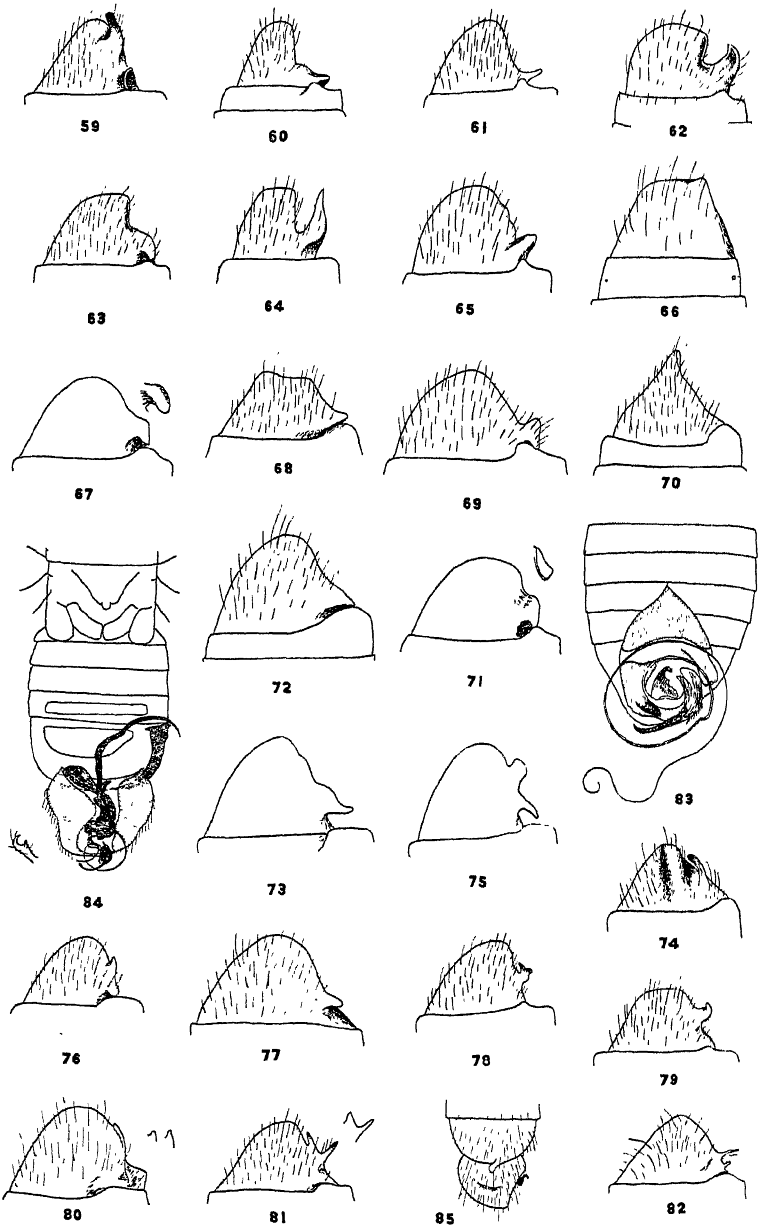
WINGS OF SCHIZOPTERINAE

FOR EXPLANATION OF PLATE SEE PAGE 38



Hypopygial Characters of Schizopterinae

For explanation of plate see page 39

# A REVIEW OF THE BEETLE FAMILY PSEUDOMORPHIDAE, AND A SUGGESTION FOR A REARRANGEMENT OF THE ADEPHAGA, WITH DESCRIPTIONS OF A NEW GENUS AND NEW SPECIES

By Howard Notman
*Of Brooklyn, New York*

In the author's opinion this group of beetles is entitled to rank as a distinct family in the Adephaga. It has been placed hitherto as a subfamily of the Carabidae, from which several characters of importance distinguish it. The most striking, perhaps, is the presence of antennal grooves on the underside of the head between the eyes and the maxillary fissures. More important, however, systematically is the absence of the suture between the mentum and the submentum. This suture is absent in the Amphizoidae also, but is present in all the remaining families of the Adephaga. It is especially well marked in the Dytiscidae. Another character not so well suited for synoptic construction but, nevertheless, more or less significant, is the variability in the form and position of the eye. This organ is always lateral in position and subrotund in form in the Carabidae. In the Pseudomorphidae the genera, which number only eight, show the following differences in form and position. In *Adelotopus* the eye is on the upper surface of the head, with a well defined, continuous margin beneath it. In *Cryptocephalomorpha* the eye is lateral in position but by its conformation continues the cephalic margin which it structurally interrupts—an extreme instance of the usually dominant eye-form in subordination to the general form of the head. The eye in this genus, as also in *Pseudomorpha*, has a strong angulation beneath. In *Silphomorpha* and *Sphallomorpha* the eye is round.

It is by no means certain that the genus *Adelotopus* should not be placed in a separate family on account of the difference in the position of the eye as described and its position anterior to the maxillary fissure, a feature characteristic of the Dytiscidae, in which the maxillary fissure extends as far back as the posterior margin of the eye, and also on account of the form of the fissure and the form of the antennae. In *Silphomorpha*, *Sphallomorpha*, and especially in *Pseudomorpha*, the posterior extremity of the fissure is acute as though obliquely truncated by the antennal groove, whereas in *Adelotopus* the antennal groove and the fissure are parallel and both are semicircularly rounded at their posterior extremities. The form of the fissure is very similar in *Dytiscus*. Also, in the latter genus, there is a distinct excavation between the eye and the fissure. The Dytiscidae in general have a tendency to hold the antennae in repose, against the underside of the head.

In the Carabidae the relation between the eye and the fissure varies considerably. In the Lebiid genus *Agra*, the eye is wholly posterior to the latter, whereas in *Anisodactylus* the fissure extends to about the posterior two-thirds of the eye. This relation is probably correlated with the feeding habits of the beetles. The fissure is apparently always rounded at its posterior extremity.

In *Silphomorpha*, *Sphallomorpha*, and *Pseudomorpha* the antennae are long and filiform as in the other families of the Adephaga; whereas in *Adelotopus*, they are very short and strongly fusiform, much more clavate than in many genera of the clavicorn family Staphylinidae. Other indications of association with that family are not lacking. The genera *Silphomorpha* and *Sphallomorpha* were separated by Westwood and later made synonymous. They seem to the author, however, to be worthy of maintenance. Westwood distinguished them by the presence of a broad, rather indistinct tooth in the species assembled in *Silphomorpha*. In addition, these species are characterized by a more or less distinct angulation of the gular sutures. Variability in the form of the gular sutures is frequent in the Staphylinidae, especially in the Lathrobia, but, as far as the author is aware, is unknown in the Carabidae. The Cryptobia, also, are recalled in the densely pubescent spots found on two of the abdominal segments in the males of *Pseudomorpha*.

The species of *Silphomorpha* are all uniform in coloration—dark piceous to nearly black. The species of *Sphallomorpha* are variegated with pale maculae, vittae, or margins.

In *Pseudomorpha*, the only genus known from the western hemisphere, the form is elongate, parallel or nearly so and moderately convex, and the color varies from castaneous to nearly black.

The legs are very short, with strongly developed femora in all the genera of the family.

In the Australian genera *Adelotopus*, *Cainogenion*, *Silphomorpha*, and *Sphallomorpha*, the form is more variable. Many species of *Adelotopus* are very elongate and cylindrical, resembling the bark beetles of the family Scolytidae. In *Sphallomorpha* the form is broad, oval, and depressed like that of the Gyrinidae and the

Dytiscidae. In *Adelotopus*, also, many of the species are variegated with maculae or fasciae of red.

The genus *Hydroporomorpha* is known from Africa. *Paussotropus*[1] and *Cryptocephalomorpha* from the East Indies. *Pseudomorpha* is also known from Australia.

*Paussotropus* in addition to characters mentioned in the synopsis is distinguished by very short tarsi and the absence of a posterior prolongation of the prosternum.

The habits of the Pseudomorphidae are not well known. Many of the Australian species are found under the bark of *Eucalyptus* trees. *Adelotopus* has been found with ants and is believed by Sloane to feed on them.[2] Some species, probably of *Sphallomorpha*, have been found on flowers and doubtless lead to their association with the *Lebias*.

Though not closely related to the subject of this paper, it may not be out of place in connection with a suggested rearrangement of the Adephaga, to call attention to the structure of the mouth in *Pasimachus*. The suture between the mentum and the submentum is very strongly developed and the maxillary fissure is much reduced. Elsewhere in the Carabidae, even in the Scaritini, where *Pasimachus* is placed by the systematists, the fissure extends some distance behind the mentum with a distinct apical arcuation inward, forming a distinct submentum, but in *Pasimachus* the fissure ends at the base of the mentum. In reality it reaches the base of the mentum only as a suture, for the basal half of the mentum is continuous with the gena and the fissure is open only for the apical half. Throughout the Carabidae, to the extent of the author's observations, the fissure is open downwards, so that considerable vertical motion is possible in the movement of the maxilla. In *Pasimachus* the mentum conceals the fissure from beneath and motion in the fissure must be altogether horizontal. These peculiarities of mouth structure, together with the large mandibles and the posterior position of the eyes, seem to afford strong grounds for erecting a distinct family for this and allied genera.

In closing this brief discussion of the Pseudomorphidae, one further point may be indicated. The mandibles are without visible scrobes. Dissection shows that this is due to the greater development of the lower edge of the mandibles; a structure corresponding to the upper edge of the scrobe, appearing as an arcuate carina on the upper surface. This recalls the expansion of the lower edge of the scrobe in the Carabid genus *Leistus*. Whether the absence of the scrobe in the two Lebiid genera *Pentagonica* and *Onota* is due to a similar development of the lower edge or not could not be ascertained from lack of material, but it seems probable that it is.

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[1] See footnote 4 on p. 5.

[2] Arthur M. Lea. Australian and Tasmanian Coleoptera inhabiting or resorting to the Nests of Ants, Bees, and Termites. Proc. Roy. Soc. Victoria, n. s. vol. 23, 1911, pp. 116–230.

The rearrangement of the Adephaga here suggested seems to bring into greater prominence characters of importance, while, perhaps, taking less account of habits of life.

The author wishes to acknowledge his indebtedness to the following for the loan of specimens, suggestive comment, or for permission to examine type material: To the British Museum, through the kindness of G. J. Arrow; to the United States National Museum, through the kindness of Dr. E. A. Schwarz; to the American Museum of Natural History, through the kindness of Dr. F. E. Lutz; to the Academy of Natural Sciences of Philadelphia, through the kindness of Dr. Henry Skinner; to the Museum of Comparative Zoology, through the kindness of Nathan Banks; to Col. Thomas L. Casey, Dr. E. C. Van Dyke, the Messrs. H. C. Fall, Charles Schaeffer, A. B. Champlain, and Prof. E. B. Poulton. The author is especially indebted to Charles Schaeffer for his encouragement and assistance in undertaking this study and in continuing it to completion.

### KEY TO THE FAMILIES OF THE ADEPHAGA[3]

1. Mentum and submentum not separated by a suture ---- 2
   Mentum and submentum separated by a distinct suture ---- 3
2. Head with antennal grooves beneath ---- **Pseudomorphidae.**
   Head without antennal grooves beneath ---- **Amphizoidae.**
3. Metasternum without an antecoxal piece; prolonged in a triangular process posteriorly ---- 4
   Metasternum with an antecoxal piece, separated by a well-marked suture ---- 5
4. Antennae irregular, very short; abdomen with seven segments; eyes four. **Gyrinidae.**
   Antennae slender, filiform or setaceous; abdomen with six segments; eyes two ---- **Dytiscidae.**
5. Antecoxal piece of the metasternum not extending from one side to the other ---- **Hygrobiidae.**
   Antecoxal piece extending from one side to the other ---- 6
6. Antennae arising on the sides of the head between the eyes and the mandibles ---- 7
   Antennae arising on the front between the eyes and above the mandibles ---- 9
7. Scutellum present ---- 8
   Scutellum absent ---- **Omophronidae.**
8. Maxillary fissures not extending to the mental suture, concealed from below by the mentum ---- **Pasimachidae.**
   Maxillary fissures surpassing the mental suture, open beneath ---- **Carabidae.**
9. Antennae 10-jointed. Hind coxae with large plates almost concealing the abdomen. Head vertical. Mandibles not prominent ---- **Haliplidae.**
   Antennae 11-jointed. Head vertical, with prominent mandibles. Hind coxae without large plates ---- **Cicindelidae.**

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[3] Certain authors have discussed adephagous affinities of the Paussidae, Rhyssodidae, and Cupesidae (Burmeister 1841, Raffray 1885, Escherich 1899, Peyerimhoff 1902, Desneux 1905, Boving 1907, and Forbes 1923), but these families are here omitted as too aberrant for inclusion.

The following are the principal papers dealing with the Pseudomorphidae, more especially the earlier species:

KIRBY, WILLIAM.—A Description of some Insects which appear to exemplify Mr. William S. MacLeay's Doctrine of Affinity and Analogy. Trans. Linn. Soc. London, vol. 14, 1825, pp. 93–110.

WESTWOOD, J. O.—Illustrations of the Relationships existing amongst Natural Objects, usually termed Affinity and Analogy, selected from the Class of Insects. Trans. Linn. Soc. London, vol. 18, 1841, pp. 409–421.

WESTWOOD, J. O.—Pseudomorpha et Adelotopus, genera duo anomalia e familia Carabidarum synoptice tractata. Rev. Zool., ser. 2, vol. 5, 1853, pp. 395–410.

MACLEAY, W., Jr.—Descriptions of new Genera and Species of Coleoptera from Port Denison. Trans. Ent. Soc. New South Wales, vol. 1, 1864, pp. 106–130.

DE CASTELNAU, Count F.—Notes on Australian Coleoptera. Trans. Roy. Soc. Victoria, vol. 8, 1868, pp. 95–225.

MACLEAY, W.—Notes on a Collection of Insects from Gayudah. Trans. Ent. Soc. New South Wales, vol. 2, 1871, pp. 79–205.

HORN, G. H.—Miscellaneous Notes and short Studies of North American Coleoptera. Trans. American Ent. Soc., vol. 10, 1882–83, pp. 269–312.

MACLEAY, W.—The Insects of King's Sound and its vicinity.
Proc. Linn. Soc. New South Wales, doc. 3, vol. 3, pt. 1, pp. 443–480, 1888.

The following key of the genera is based on the original descriptions only in the case of *Paussotropus* and *Hydroporomorpha* since no specimens of the species in those two genera could be obtained for examination. They are marked with an asterisk to indicate this fact.

KEY TO THE GENERA OF THE PSEUDOMORPHIDAE

1. Eyes superior in position ---------- 2
   Eyes lateral in position ---------- 3
2. Head with a continuous margin beneath the eye. Prosternum not depressed behind the coxae ---------- **Adelotopus** Hope.
   Head with the margin interrupted beneath the eye. Prosternum depressed behind the coxae. A prominent process between the eye and the maxillary fissure ---------- **Cainogenion**, new genus.
3. Head deflexed. Front very convex. Mouth inferior ---------- 4
   Head horizontal. Mouth anterior ---------- 5
4. Labrum and mandibles invisible from in front. Eyes angulate beneath. **Cryptocephalomorpha** Ritsema.
   Labrum and mandibles visible from in front. Eyes round. * **Paussotropus**[4] Waterhouse.
5. Eyes angulate beneath. Head with short antennal grooves; not surpassing the eyes ---------- **Pseudomorpha** Kirby.
   Eyes round. Head with long antennal grooves, far surpassing the eyes ---------- 6
6. Mentum entire. Ventral segments four ---------- * **Hydroporomorpha** Westwood.
   Mentum emarginate. Ventral segments six ---------- 7

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[4] One species of this genus is known, *P. parallelus* Waterhouse. Trans. Ent. Soc., London, 1877, p. 3. In response to an inquiry concerning this species, Mr. G. J. Arrow writes: "As to *Paussotropus* there appears to have been a mistake, * * *. The type specimen bears the locality "Batchian," but this evidently incorrect, for we have since acquired two specimens taken by Du Boulay in West Australia and one labeled "Adelaide." * * * The form of the head is very remarkable. The eye is nearly circular and placed laterally, its anterior edge just reaching the front margin of the head, but the declivity of the head is elevated immediately in front of the eye and forms a peculiar cup-shaped lobe as seen from the side."

7. Mentum with a short broad tooth. Gular sutures strongly angulate. Color uniform piceous or black---------------- **Silphomorpha** Westwood.
   Mentum without a tooth. Gular sutures not angulate. Elytra maculate or vittate or with broad pale margins (metallic green in *speciosa* Pascoe). **Sphallomorpha** Westwood.

### Genus ADELOTOPUS Hope

The following key was prepared in large part from the original descriptions only. Such species as could *not* be identified in the material at hand are marked with an asterisk. Specimens of *Adelotopus dytiscoides* Newman, *Adelotopus ipsoides* Westwood, and *Adelotopus rubiginosus* Newman which had been compared with the types were obtained through the kindness of G. J. Arrow, of the British Museum, who also compared a specimen from the collection of the American Museum of Natural History with the type of *Adelotopus gyrinoides* Hope and identified it as that species. Complete descriptions are given for those species only, believed to be undescribed.

#### KEY TO SPECIES OF GENUS ADLOTOPUS HOPE

1. Head with two horn-like tubercles------------------ * **cornutus** Castelnau.
   Head without tubercles------------------------------------------- 2
2. Whole upper surface setose, with pale erect hairs------ * **analis** MacLeay.
   Upper surface not setose------------------------------------------ 3
3. Head with intraorbital setigerous punctures------------ * **insignis** Sloane.
   Head without intraorbital setigerous punctures----------------------- 4
4. Form very broad. Thorax three times as broad as long. Elytra about as long as broad------------------------------------- * **celeripes** Lea.
   Form elongate. Elytra distinctly to strongly elongate. Thorax not more than twice as broad as long------------------------------------ 5
5. Elytra unicolorous or nearly so------------------------------------ 6
   Elytra bicolored; maculate, fasciate or with apex rather broadly and definitely red------------------------------------------------ 25
6. Color black or piceous black--------------------------------------- 7
   Color pale castaneous or brownish---------------------------------- 19
7. Elytra with punctation extremely minute----------------------------- 8
   Elytra distinctly punctate. Abdomen red---------------------------- 18
8. Elytra with the minute punctation variolose. Thorax twice as wide as long------------------------------------------- * **variolosus** Lea.
   Elytral punctation not variolose------------------------------------ 9
9. Thorax with all the angles very acute. Form elongate. Elytra three times the length of the thorax------------------ * **elongatulusMacLeay.**
   Thorax with the posterior angles much less distinct------------------ 10
10. Abdomen, ferruginous or red--------------------------------------- 11
    Abdomen black or piceous black------------------------------------ 13
11. Form elongate, narrower-------------------------- * **tasmani** Blackburn
    Form broader---------------------------------------------------- 12
12. Scutellum and margins of thorax and elytra paler, piceous. * **scolytides** Newman.
    Scutellum and margins of thorax and elytra not paler. **hydrobioides** Westwood.

13. Size larger. 9 mm. Basal margin of elytra entire, attaining the scutellum ---------- 14

Size smaller, not more than 7 mm. Basal margin of elytra abbreviated, not attaining the scutellum ---------- 15

14. More shining ---------- **mastersi** MacLeay.

Alutaceous, subopaque ---------- **dytiscoides** Newman.

15. Elytra shorter, twice the length of the thorax. Form ovate. * **brevipennis** MacLeay.

Elytra longer, nearly three times the length of thorax. Form narrower ---------- 16

16. Form narrower, more cylindrical. Abdomen black ---------- **niger**, new species.

Form broader, more depressed ---------- 17

17. Thorax much broader, more than twice as broad as long. Abdomen black. * **vicinus** Castelnau.

Thorax narrower, not more than twice as broad as long. Abdomen paler, piceous ---------- **gyrinoides** Hope.

18. Thorax narrower than the elytra ---------- **occidentalis** Castelnau.

Thorax as wide as the elytra. Suture subcarinate apically. * **micans** Blackburn.

19. Alutaceous, rather opaque. Head deeply immersed in the thorax. * **brunneus** Castelnau.

Strongly shining ---------- 20

20. Densely punctate, though shining ---------- * **punctatus** Castelnau

Punctation rather sparse or wanting ---------- 21

21. Size smaller, about 3 mm ---------- 22

Size larger, 4–6 mm ---------- 23

22. Color ferruginous, uniform. Thorax and elytra of equal width. Very minutely punctate and feebly striate ---------- **rubiginosus** Newman.

Color pale, rufo-piceous, a little darker on head and thorax. Very shining, impunctate. Elytra a little narrower than thorax ---------- * **laevis** MacLeay.

23. Form broader. Thorax two-thirds wider than long. Sides subparallel posteriorly, rounded anteriorly. Punctation fine but distinct. Size 6 mm ---------- **aphodioides** Westwood.

Form elongate, cylindrical ---------- 24

24. Thorax nearly as long as broad. Elytra slightly narrower than thorax. Punctation very indistinct. Size 6 mm ---------- * **longipennis** MacLeay.

Thorax rather strongly transverse, as wide as elytra, sides straight, narrowed from the base. Punctation more distinct. Size 4 mm. **castaneus** Castelnau.

25. Elytra with the apex more or less broadly reddish ---------- 26

Elytra maculate or fasciate ---------- 33

26. More or less alutaceous and dull. Form elongate, cylindrical, parallel. Thorax longer than broad ---------- * **linearis** MacLeay.

Shining ---------- 27

27. Thorax subquadrate or longer than broad ---------- 28

Thorax distinctly transverse ---------- 29

28. Thorax longer than wide. Apical third or half of the elytra red. * **filiformis** MacLeay.

Thorax subquadrate. Elytral apex less broadly red. **nemosomoides** Westwood.

29. Form broader, less oblong ---------- **apicalis** MacLeay.

Form narrower, more parallel ---------- 30

30. Thorax impunctate ---------- 31

Thorax with distinct punctation ---------- 32

31. Elytra with sides nearly straight and distinctly narrowed posteriorly. Elytral truncations slightly emarginate---------- * **jacobsoni** Ritsema.
    Elytra with sides parallel, slightly arcuate. Elytral truncations feebly arcuate-------------------------------- **haemorrhoidalis** Erichson.
32. Thorax punctate medially. Elytral punctation duplex, not regularly seriate. Elytra about half red---------------- **puncticollis**, new species.
    Thorax punctate laterally only. Elytra with nine regular rows of punctures. Apex red----------------------- **serie-punctatus**, new species.
33. Elytra maculate---------------------------------------------------- 34
    Elytra fasciate----------------------------------------------------- 35
34. Elytra with a large, common red macula-------- * **maculipennis** MacLeay.
    Elytra with a red macula on the center of each---- * **bimaculatus** MacLeay.
35. Thorax wider than elytra-------------------------------------------- 36
    Thorax not wider than elytra---------------------------------------- 37
36. Form broader. Basal fascia not extending to one-half the length of the elytra------------------------------------------ **affinis** Castelnau.
    Form elongate, cylindrical. Thorax narrowed anteriorly. Elytra with two fasciae. Basal fascia much narrower----------- * **zonatus** Castelnau.
37. Thorax about as long as wide, not narrowed in front. Basal fascia covering two-thirds of the elytra. Form elongate, cylindrical. * **fasciatus** Castelnau.
    Thorax transverse, much narrowed in front. Elytra short. Form broader. * **papuanus** Gestro.

### ADELOTOPUS NIGER, new species

Form elongate, cylindrical, subparallel, nearly three times as long as broad; widest at the middle; sides feebly and evenly arcuate. Color black. Margins of thorax and elytra very finely picescent. Legs, antennae, and mouth parts picescent. Head subimpunctate. Thorax and elytra rather minutely and sparsely and irregularly punctate. Elytra without striae. Suture feebly elevated at apex. Head three-fourths the width of thorax. Thorax slightly more than one-half wider than long. Apex arcuate; sides feebly arcuate and narrowed from base to apex; base very feebly and broadly emarginate. All angles rather narrowly rounded; anterior angles projecting for about one-third the diameter of the eye. Sides rather narrowly reflexed. Base not margined. Thorax not more coarsely nor closely punctured apico-laterally. Elytra more than twice the length of thorax; humeri rounded and less prominent than adjacent thoracic base; basal margin subobsolete. Apical truncatures feebly arcuate; outer apical angles broadly rounded; sutural moderately narrowly rounded. Prosternum indistinctly and sparsely punctured; abdomen rather coarsely and closely punctured laterally. Length, 5.8 mm.; width, 2.1 mm.

*Type.*—Australia (Koebele). Cat. No. 26168, U.S.N.M.

The apex of the thorax is quite distinctly more arcuate in this species than in my new species *A. puncticollis*, and *A. serie-punctatus.*

### ADELOTOPUS PUNCTICOLLIS, new species

Form elongate, cylindrical, subparallel, about two and one-half times as long as wide; widest near the middle; sides distinctly and evenly arcuate. Integuments very shining. Color black. Elytra with posterior two-thirds red on the disk; the black extending somewhat broadly laterally to apical third. Margins of thorax and elytra finely picescent. Mouth parts, antennae, legs, and abdomen bright rufo-castaneous. Head two-thirds the width of thorax, moderately convex, distinctly and rather irregularly punctate. Thorax one-fourth wider than long, sides rather feebly arcuately narrowed from base to apex; anterior angles projecting for about one-third the diameter of the eye, narrowly rounded; sides narrowly reflexed; basal angles rounded. Surface distinctly and irregularly punctured, more coarsely and densely apico-laterally. Elytra rather more than twice the length of thorax, distinctly and irregularly punctured; punctures varying in size, the larger forming irregular longitudinal series on basal portion. Basal margin broadly interrupted medially. Striation very faint. Suture very finely margined, feebly elevated close to the apex. Apical truncatures feebly arcuate; outer angles broadly rounded; sutural angles very narrowly rounded. Sterna rather coarsely, sparsely, and irregular punctured. Abdomen extremely minutely and sparsely punctate and setulose. Length, 5 mm.; width, 2 mm.

*Type.*—Victoria (Hy Edwards Coll.). Collection of the American Museum of Natural History.

### ADELOTOPUS SERIE-PUNCTATUS, new species

Form elongate, cylindrical, slightly wider near elytral apex; sides scarcely arcuate; rather more than twice as long as wide. Very shining. Color black; elytral apex rather broadly red. Antennae, mouth parts, legs, and abdomen bright rufo-castaneous. Head two-thirds the width of thorax, moderately convex, impunctate. Thorax rather more than one-fourth wider than long; sides rather distinctly narrowed anteriorly, feebly arcuate. Anterior angles closely embracing the head but small, scarcely surpassing the posterior margins of the eye, narrowly rounded. Side margins narrowly reflexed. Disk impunctate; sides with few rather coarse punctures, more numerous near apical angles. Elytra twice the length of the thorax; margins very narrowly reflexed; basal margin broadly interrupted medially; disk with nine regular series of strong, asperate punctures; finer near the apex. Striation completely obsolete; suture very finely margined, distinctly elevated near the apex; apical truncatures nearly straight; outer angles very broadly rounded; sutural angles moderately narrowly rounded. Sterna coarsely, sparsely, and irregularly punctured. Abdomen with numerous, distinct setulose punctures, finer and sparser on sixth segment. Length, 6 mm.; width, 2.5 mm.

*Type.*—Victoria (Hy Edwards Coll.). Collection of the American Museum of Natural History.

The following species of *Adelotopus* are identified in the material at hand:

### ADELOTOPUS HYDROBIODES Westwood

Victoria.—Coll. A.M.N.H.

### ADELOTOPUS MASTERSI MacLeay

Forest Reef, New South Wales (Lea).—Coll. A.M.N.H.

### ADELOTOPUS DYTISCOIDES Newman

Victoria (3), Tasmania (1), Victoria, Austral. (Edwards Coll.) (5), New South Wales, Austral. (Edwards Coll.), Mt. Lofty Rgs. S. H. Curnow (Lea) (4).—Coll. A.M.N.H.

Australia (Koebele) (5).—Coll. U.S.N.M.

Nov. Holl. Austr. (Fry Coll.) 1905, 100.—Coll. Notman.

### ADELOTOPUS GYRINOIDES Hope

Victoria.—Coll. A.M.N.H.

### ADELOTOPUS OCCIDENTALIS Castelnau

Bridgetown (Lea).—Coll. A.M.N.H.

### ADELOTOPUS RUBIGINOSUS Newman

Port Bowen, 75.22.—Coll. Notman.

### ADELOTOPUS APHODIOIDES Westwood

South Australia, (5), Longreach, Queensland (A. M. Lea) (2).—Coll. A.M.N.H.

### ADELOTOPUS CASTANEUS Castelnau

Victoria (4), Longreach, Queensland (A. M. Lea) (2).—Coll. A.M.N.H.

### ADELOTOPUS NEMOSOMOIDES Westwood

Victoria.—Coll. A.M.N.H.

### ADELOTOPUS APICALIS MacLeay

Victoria, Hobart, Tasmania (Lea), inquiline.—Coll. A.M.N.H.

### ADELOTOPUS HAEMORRHOIDALIS Erichson

Victoria (2).—Coll. A.M.N.H.

### ADELOTOPUS AFFINIS Castelnau

Cairns, Q. (A. M. Lea).—Coll. A.M.N.H.

## CAINOGENION, new genus

*Genotype.—Adelotopus ipsoides* Westwood.

Front margin of head not continuous beneath eye, where it is interrupted by a vertical groove which descends to base of antenna but is apparently not an antennal groove. Eyes rounded oval with the long axis nearly vertical. Antennae very short, stout, fusiform, strongly compressed. That portion of the gena between eye and maxillary fissure supporting a large projecting process with a truncate apex.

Carinate median projection of prosternum strongly depressed behind coxae so that posterior extremity is in contact with mesosternum, not raised above it by a vertical edge as in *Adelotopus.*

Thorax and elytra coarsely and deeply punctured.

Posterior angles of thorax produced posteriorly.

The separation of this genus from *Adelotopus* was suggested by Newman.[5] It seems abundantly distinct by the characters given above.

In the following synopsis such species as could *not* be identified in the material at hand are marked with an asterisk, their position being determined from the original description only.

### KEY OF SPECIES OF GENUS CAINOGENION

| | | |
|---|---|---|
| 1. | Prosternum not carinate, obtusely elevated posteriorly | 2 |
| | Prosternum with a strong median carina on posterior half | 4 |
| 2. | Sides of thorax subangulate anteriorly. Color rufotestaceous. | * **cylindricum** Chaudoir. |
| | Sides of thorax evenly rounded. Color darker, with a pale basal area on elytra | 3 |
| 3. | Integuments finely granulate throughout | * **bicolor** Castelnau. |
| | Integuments smooth and shining though punctate | **ephippiatum** Newman. |
| 4. | Elytra strongly punctured throughout | **obscurum** Castelnau. |
| | Elytra with humeral, lateral or apical areas much less distinctly punctured | 5 |
| 5. | Humeri only impunctate. Form more elongate | * **creberrimum** Blackburn. |
| | Humeri, sides, and apex impunctate or nearly so | **ipsoides** Westwood. |

The following species of *Cainogenion* are identified in the material at hand:

### CAINOGENION EPHIPPIATUM Newman

Victoria (5).—Coll. A. M. N. H.

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[5] Trans. Ent. Soc. Lond., 1856, vol. 3, new series, p. 127.

### CAINOGENION OBSCURUM MacLeay

New South Wales, Austral. (Edwards Coll.) (3), Albury, New South Wales.

(A. M. Lea, Beltana, Nov. 30, 1887 (Lea).—Coll. A. M. N. H.

New South Wales, Australia, Jan., 1901, Geo. Compere, Collector (2).—Coll. U. S. N. M.

### CAINOGENION IPSOIDES Westwood

Victoria (4).—Coll. A. M. N. H.

Melbourne (Bowring 63.47*), Adelaide (Bowring 63.47*).—Coll. Notman.

## Genus CRYPTOCEPHALOMORPHA Ritsema

It is uncertain whether *Adelotopus collaris* Waterhouse, from Siam, should be placed in this genus. It is the only species described from anywhere but Australia, whereas *Cryptocephalomorpha gaverei* Ritsema is known from Java.[6] If examination of the type shows the species to belong here, it may be distinguished as follows. A specimen of *Cryptocephalomorpha marginatus* Westwood (=*gaverei* Ritsema), which has been compared with the type, was obtained through the kindness of G. J. Arrow, of the British Museum.

### KEY OF SPECIES OF GENUS CRYPTOCEPHALOMORPHA RITSEMA

Elytra each with a round yellow macula________________collaris Waterhouse.
Elytra each with an oblique red macula____________________gaverei Ritsema.

## Genus PSEUDOMORPHA Kirby

The material at hand in this genus includes representatives of all the described species with the exception of *cylindrica* Casey from North America and *laevissima* Chaudoir, *gerstaeckeri* Chaudoir, and *argentina* Steinheil, from South America. The author was kindly allowed the privilege of examining the type of *cylindrica* in the collection of its describer.

*Laevissima* Chaudoir, *gerstaeckeri* Chaudoir and *hubbardi* Notman, are probably distinguishable by an impunctuate thorax. The remaining species fall into several series by characters of the head. In *angustata* Horn, *champlaini* Notman, *schwarzi* Notman, *confusa* Notman, and *cylindrica* Casey, there is a well-marked transverse row of coarser punctures on the occiput which is lacking or indistinct in the others, including *hubbardi* Notman,. In another series the front margin of the head between the eye and the base of the mandibles forms a very distinct lobe, which is arcuate and usually more prominent at its anterior end near the mandibles. In *cronkhitei* Horn and *excrucians* Kirby, the apex of the lobe is truncate and about equally prominent at either end. This series includes *angustata* Horn and the related species, *champlaini* Notman, *schwarzi* Notman, also the species *lacordairei* Depan, *arrowi* Notman, *behrensi* Horn, *castanea* Casey, *vindicata* Notman, and *hubbardi* Notman. Another interesting character which it was not found necessary to use in the synoptic analysis is found in the margination of the base of the thorax. In the species *pilatei* Chaudoir, *tenebroides* Notman, *alutacea* Notman, *vandykei* Notman, *consanguinea* Notman, the thorax is finely margined medially at base. This margin is beaded with the setigerous punctures which are found in a series around the lateral edges of both thorax and elytra. The other species are without this margin with the exception of *confusa* Notman. In the type of the latter the base of the thorax is finely and completely margined. The margin is not, however, beaded with the setigerous punctures. In the *angustata* series the head is distinctly less transverse than in the other species. The elytral punctuation in *confusa* Notman, and *hubbardi* Notman, is simple, consisting of rows of coarse punctures only. In the others the punctures are both coarse and fine, the coarse in rows but the fine sometimes without distinct arrangement. The anal setigerous punctures exhibit a large amount of variability. The number often differs on either side in individuals. Some have but two on either side; others as many as five. The latter was found to be the number in a male *excrucians* Kirby and a female *behrensi* Horn. There appears to be no difference in the number between the sexes. The number averages lowest in *angustata* Horn, and its relatives.

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[6] Ritsema, Tijds. v. Ent., vol. 22, 1878–1879, pp. lxxxvii–lxxxviii.

The proportions of the thorax are often deceptive and therefore more or less unreliable on account of a tendency to distortion through warping of the integuments.

E. A. Schwarz, who has made a study of the genus, kindly turned over his notes to the author. Characters of systematic value, the transverse row of coarse punctures on the head and the variation in the width of the pubescent spots on the third and fourth abdominal segments of the male, are indicated by him. The former character is made use of in the synopsis of the species. The male character will distinguish *schwarzi* Notman and *champlaini* Notman from *angustata* Horn, the spots being narrower in the former.

Dr. Schwarz writes that the *Pseudomorphas* are numerous in their habitat, but are difficult to capture. They live in dead leaves and move with great agility, assisted by the numerous setae with which they are provided. They are easy to capture on cloth when attracted to light. A large series was collected by Dr. E. E. Lutz in Arizona by the latter method.

In the following synopsis the species known *only* from the original descriptions are marked with an asterisk. *Pseudomorpha argentina* Steinheil is omitted because of the impossibility of placing it by the original description. Complete descriptions are given only for the species believed to be undescribed.

### KEY TO SPECIES OF GENUS PSEUDOMORPHA KIRBY

1. Elytra with five distinct longitudinal sulcations on the disk. **falli, new species.**

Elytra without sulcations ---- 2

2. Thorax punctate ---- 5

Thorax impunctate ---- 3

3. Elytra impunctate ---- *** laevissima Chaudoir.**

Elytra punctate ---- 4

4. Elytra parallel ---- *** gerstaeckeri Chaudoir.**

Elytra distinctly narrowed posteriorly ---- **hubbardi, new species.**

5. Head with a distinct transverse row of coarser punctures on vertex ---- 18

Head without a distinct transverse row of coarser punctures on vertex ---- 6

6. Head with rather prominent preocular clypeal lobe ---- 12

Head without distinct preocular clypeal lobe ---- 7

7. Elytra shining, not at all alutaceous, punctuation finer ---- **pilatei Chaudoir.**

Elytra less shining, distinctly alutaceous ---- 8

8. Form more elongate parallel, cylindrical; head large, three-fourths the width of the thorax; sides of the thorax subparallel ---- **tenebroides, new species.**

Form broader; head proportionally much smaller; thorax distinctly narrowed anteriorly ---- 9

9. Form rather short, parallel; elytra with the second, fourth, sixth, eighth, and ninth series composed of coarser punctures; the fourth and sixth somewhat abbreviated basally ---- **alutacea, new species.**

Form a little more slender, distinctly narrowed posteriorly ---- 10

10. Elytra with rows of punctures finer throughout and somewhat indistinct. Form rather less convex. Thorax shorter and head smaller. **vicina, new species.**

Elytra with distinct rows of coarser punctures ---- 11

11. Thorax more transverse. Sides more rounded and narrowed anteriorly. Elytra with three rows of coarser punctures, all abbreviated basally. Outer two not reaching the middle ---- **van dykei, new species.**

Thorax less transverse, less narrowed anteriorly. Elytra with the second, fourth, sixth, and eighth series of coarser punctures subentire. First and second series also with coarser punctures ---- **consanguinea, new species.**

12. Elytra finely alutaceous, less shining ---- 13

Elytra not alutaceous, strongly shining ---- 16

13. Form distinctly narrowed posteriorly ---- 14

Form parallel ---- 15

14. Elytral punctuation very fine, subobsolete ---- **cronkhitei Horn.**

Elytra with eight rows of punctures. The seventh of fine, the others of coarse punctures ---- **vindicata, new species.**

15. Elytra with the rows of punctures confused on the disk ---- **behrensi Horn.**

Elytra with the rows of punctures distinct throughout ---- **castanea Casey.**

16. Thorax more coarsely and densely punctured apico-medially. **arrowi, new species.**

Thorax not punctured as above ---- 17

17. Color rufous. Elytra blackish piceous. Thorax less transverse. Elytra less elongate---------- **excrucians** Kirby.
Color above entirely blackish piceous. Thorax more transverse. Elytra more elongate---------- **lacordairei** Dejean.
18. Elytra finely alutaceous, less shining, with nine rows of coarse punctures. **confusa**, new species.
Elytra not alutaceous, strongly shining---------- 19
19. Form very elongate, cylindrical. Head scarcely narrower than thorax. Elytra with two rows of coarser punctures---------- **cylindrica** Casey.
Form broader. Head distinctly narrower than the thorax----------20
20. Head larger, about two-thirds the width of thorax. Elytra with a single row of coarser punctures near suture---------- **angustata** Horn.
Head smaller, scarcely more than one-half the width of thorax. Elytra with two rows of coarser punctures----------21
21. Unicolorous above. Thorax more transverse, with sides more strongly rounded---------- **champlaini**, new species.
Head and thorax rufous; elytra blackish piceous. Thorax less transverse, with sides less strongly rounded. Size smaller--- **schwarzi**, new species.

### PSEUDOMORPHA FALLI, new species

Form rather slender and cylindrical. Color dark castaneous. Integuments finely alutaceous, moderately shining. Head with sparse, fine punctuation; thoracic punctuation sparse, fine, and very indistinct; a few faint rugae postero-laterally. Elytra with eight rows of strong, coarse punctures, somewhat abbreviated basally; a few fine punctures in the intervals or in the rows of coarser punctures. Discal intervals distinctly longitudinally impressed. Head large, two-thirds the width of thorax, rather more than twice as wide as long; preocular lobes not distinct; clypeal suture not distinct. Antennae rather long, slightly surpassing anterior coxae. Thorax twice as wide as long. Sides moderately narrowed anteriorly, evenly and not strongly arcuate; a faint longitudinal median impressed line. Base not margined at any point. Elytra scarcely visibly wider than thorax, three times as long as latter. Sides parallel; apices truncate; outer angles rounded, inner narrowly rounded. Length, 6.4 mm.; width, 2.7 mm.

*Male.*—Densely pubescent spot at the middle of the fourth and fifth ventral segments about one-seventh the width of the segment.

*Type.*—Male. San Diego County, California. Jacumba, July 1, 1907. G. H. F. Collection of H. C. Fall.

### PSEUDOMORPHA HUBBARDI, new species. (Schwarz Mss.)

Form rather broad and depressed. Color varying from pale ferruginous to blackish piceous. Integuments above finely alutaceous. Head with two or three punctures near eye. Thorax impunctate. Elytra with four rows of coarse punctures, rather widely spaced. Head three-fifths the width of thorax, about twice as wide as long. Preocular lobe somewhat distinct; clypeal suture feebly marked.

Antennae short, not surpassing the anterior coxae. Thorax twice as wide as long, as wide as elytra; apex feebly emarginate; anterior angles very broadly rounded; sides rounded and convergent anteriorly; posterior angles broadly rounded; margins finely reflexed; base finely margined medially; a fine median carina behind the middle. Elytra about three-fifths longer than wide, scarcely more than twice the length of thorax, distinctly narrowed posteriorly; apex obliquely truncate; outer angles broadly rounded, inner rather narrowly rounded; suture feebly elevated apically. Length, 6.75–7.75 mm.; width, 3–3.5 mm.

*Male.*—Densely pubescent spot at the middle of the fourth and fifth ventral segments, about one-seventh the width of the segment.

*Type.*—Male. Allotype and 1 paratype (female), Rincon Mountains, Arizona. July, 1907. Collection of the author.

Paratype (female). Rincon Mountains, Arizona. July, 1907. Collection of the British Museum.

Paratype (female). Rincon Mountains, Arizona. July, 1907. Collection of the Academy of Natural Sciences of Philadelphia.

Paratype (female). Tucson, Arizona. July 21, 1913 (Shreve). Collection of the Bureau of Plant Industry, Harrisburg, Pennsylvania.

Paratype (female). Huachuca Mountains, Arizona (Palm Coll.). Collection of the American Museum of Natural History, New York.

Four paratypes (2 males, 2 females). Fort Grant, Arizona. July 12, 15, and 23 (Coll. Hubbard and Schwarz). Collection of the United States National Museum.

*Paratypes.*—Cat. No. 26169, N.S.N.M.

### PSEUDOMORPHA TENEBROIDES, new species. (Schwarz Mss.)

Form elongate, parallel, cylindrical. Color dark rufo-piceous. Integuments finely alutaceous, rather feebly shining. Head and thorax with fine, irregularly scattered punctures. Elytra finely and sparsely punctured with four rows of widely separated coarse punctures; the three outer rows much abbreviated basally. Head large, three-fourths the width of thorax, twice as wide as long. Preocular lobe not at all prominent; clypeal suture obsolete. Antennae moderate in length, slightly surpassing the anterior coxae. Thorax one-half wider than long, as wide or slightly narrower than elytra, sides straight and parallel behind the middle, feebly convergent and arcuate anteriorly. Apex feebly emarginate; anterior angles not prominent, posterior angles rounded; a faint median carina at base; base feebly margined medially. Elytra two and one-half times as long as the thorax, twice as long as wide; sides parallel or slightly divergent posteriorly, straight to apical three-fourths; margins very finely reflexed; suture feebly elevated apically; apices obliquely truncate; outer angles broadly rounded, inner moderately rounded. Length, 8 mm.; width 3 mm.

*Male.*—Densely pubescent spot on the middle of the fourth and fifth segments, broad, a little more than one-fourth the width of the segment.

*Type.*—Male. Tucson, Arizona. June 22 (Coll. Hubbard and Schwarz). Cat. No. 26170, U.S.N.M.

### PSEUDOMORPHA ALUTACEA, new species

Form rather short, parallel, moderately convex. Color dark rufopiceous. Integuments above finely alutaceous. Head and thorax finely and sparsely punctured. Elytral punctuation as given in the synopsis. Head about three-fifths the width of the thorax, twice as wide as long. Preocular lobe not prominent; clypeal suture rather distinctly impressed throughout. Antennae rather long, surpassing considerably the anterior coxae. Thorax about four-fifths wider than long. Apex feebly emarginate; anterior angles not prominent, rounded. Sides moderately arcuate and convergent; posterior angles rounded. Base finely margined medially; side margins finely reflexed; sides moderately explanate anteriorly; a very fine and almost entire median line, very feebly impressed. Elytra scarcely more than twice the length of thorax, about one-half longer than wide, sides parallel to apical two-thirds; suture broadly and feebly prominent near the apex; apices obliquely truncate; angles rounded, outer broadly. Length, 7.25 mm.; width, 3.25 mm.

*Type.*—Female. Mesilla, New Mexico, 1897 (Cockerell). June 30. Cat. No. 26171, U.S.N.M.

### PSEUDOMORPHA VICINA, new species

Form somewhat broad, moderately convex. Color dark piceo-castaneous. Integuments very finely alutaceous, rather moderately shining. Head very finely, sparsely, and indistinctly punctured. Occipital row of punctures just traceable. Thorax subimpunctate medially, distinctly punctate laterally. Elytra with nine or more somewhat irregular rows of fine punctures, alternate rows of slightly larger punctures. Head rather small, slightly more than half the width of thorax, about twice as wide as long. Preocular lobes not distinct; clypeal suture faintly impressed. Antennae rather short, scarcely surpassing the anterior coxae. Thorax about twice as wide as long, fully as wide as any part of elytra, rather strongly narrowed anteriorly, with sides only moderately arcuate. Base not margined at any point. Elytra about two and one-half times the length of thorax. Sides distinctly narrowed posteriorly; nearly straight.

Apices rather feebly truncate; outer angles broadly rounded; inner angles also rather broadly rounded. Length, 7.5 mm.; width, 3.2 mm.

*Male.*—Densely pubescent spots on the third and fourth ventral segments about one-seventh the width of the segment.

*Type.*—Male. San Diego County, California. Jacumba July 1, 1907. G. H. F. Paratype (male) Sutro, Nevada. Collection of H. C. Fall.

### PSEUDOMORPHA VAN DYKEI, new species

Form somewhat elongate, slightly depressed. Color blackish piceous, margins paler. Integuments above finely alutaceous, somewhat feebly shining; head and thorax finely and rather sparsely punctured; elytra punctured as given in the synopsis. Head three-fifths the width of the thorax, twice as wide as long. Preocular lobes not prominent; clypeal suture very indistinct. Antennae rather long, surpassing considerably the anterior coxae. Thorax twice as wide as long, as wide or wider than elytra. Apex feebly emarginate, anterior angles rounded; sides broadly arcuate and convergent anteriorly, posterior angles rounded; sides rather broadly explanate, with margin finely reflexed. Base finely margined medially, a fine and feebly impressed median line anteriorly, a very faint and short carina near the base. Elytra nearly two and one-half times the length of the thorax, slightly more than one-half longer than wide; sides distinctly convergent behind the middle, suture broadly and feebly elevated on apical half; apices obliquely truncate, with the angles rounded as usual. Length, 7.25 mm.; width, 3.5 mm.

*Type.*—Female. Santa Cruz Village, Cobabi Mountains, Arizona. August 10–12, 1916. 32° 1′ N., 111° 54′ W., about 3,100 feet (Lutz) collected at light. Collection of the American Museum of Natural History.

### PSEUDOMORPHA CONSANGUINEA, new species

Form slightly elongate, moderately convex. Color dark piceo-castaneous. Integuments above finely alutaceous, rather feebly shining. Head and thorax very finely and rather sparsely punctured; elytra as given in the key. Head three-fifths the width of thorax, twice as wide as long. Preocular lobe not prominent; clypeal suture distinctly impressed. Antennae rather long, surpassing the anterior coxae. Thorax about three-fourths wider than long, as wide as or slightly wider than the elytra; apex feebly emarginate; anterior angles rounded; sides moderately arcuate and convergent; posterior angles rounded. Base finely margined medially; sides scarcely explanate. A fine and much-abbreviated median line, feebly and broadly impressed. Elytra somewhat more than twice the length of thorax, slightly more than one-half longer than wide; sides distinctly convergent behind the middle; suture broadly and feebly elevated behind the middle; apices truncate and angles rounded as usual. Length, 9 mm.; width, 4 mm.

*Type.*—Male. San Diego County, California. Morena Dam. July 4, 1907. G. H. F. Collection of H. C. Fall.

*Allotype.*—Dewey, Arizona. July 10–20, 1917. Collection of E. C. Van Dyke.

### PSEUDOMORPHA VINDICATA, new species

Form slightly elongate, rather depressed. Color rufo-piceous. Integuments finely alutaceous, rather feebly shining. Head and thorax finely and rather sparsely punctured, sparser medially; elytra as given in the key. Head about three-fifths the width of the thorax, twice as wide as long. Preocular lobes prominent, strongly rounded; clypeal suture distinct. Antennae (tips broken off in the type) probably long, surpassing the anterior coxae. Thorax rather more than twice as wide as long; apex very feebly emarginate; sides broadly arcuate and convergent; posterior angles rounded; base not margined medially; sides scarcely explanate; median line subobsolete. Elytra more than two and one-half times the length of the thorax, somewhat more than one-half longer than wide; sides distinctly convergent from the base; suture broadly and feebly elevated near the apex; apices rather less strongly truncate than usual. Length, 9 mm.; width, 3.75 mm.

*Male.*—Densely pubescent spots on the fourth and fifth ventral segments about one-sixth the width of the segment. Five setigerous punctures either side at the apical margin of the last segment.

*Type.*—Male. Stockton, Utah. August 1–7 (Spalding). Collection of the author.

### PSEUDOMORPHA ARROWI, new speecies

Form slightly elongate, moderately convex. Color blackish pieceous above, dull rufous beneath. Thorax and elytra polished, shining, not at all alutaceous; head finely alutaceous. Head moderately finely and sparsely punctured; thorax as in the key. Elytra with nine rows of coarse punctures, seventh in part composed of fine punctures. Head three-fifths the width of thorax, twice as wide as long. Preocular lobes prominent, subtruncate; clypeal suture distinct laterally. Antennae far surpassing the anterior coxae. Thorax three-fourths wider than long. Apex emarginate; anterior angles somewhat prominent; sides arcuate and convergent anteriorly; posterior angles rounded; sides feebly explanate; base not margined medially; an extremely fine median carina on apical half. Elytra not quite two and one-half times the length of thorax, about one-half longer than wide; sides probably slightly convergent behind the middle (not exactly determinable owing to the parting of the elytra). Sutures scarcely elevated posteriorly; apices rather obliquely and feebly subtruncate; inner angles unusually broadly rounded. Length, 9.5 mm.; width, 4.25 mm.

*Type.*—Female. Ciudad, Durango, Mexico 8100 feet. Forrer. Collection of the British Museum.

### PSEUDOMORPHA CONFUSA, new species

Form elongate, subparallel, depressed. Color blackish piceous. Integuments above finely alutaceous, moderately shining. Head with a few scattered, coarse punctures, more numerous laterally. Thorax with sparsely scattered, coarse punctures; elytra punctured as given in the key. Head slightly more than half the width of thorax, not twice as wide as long. Preocular lobes very prominent, oblique; clypeal suture not distinct. Antennae broken, probably surpassing the anterior coxae. Thorax twice as wide as long; apex emarginate; anterior angles somewhat prominent, rounded; sides rather strongly arcuate and convergent anteriorly; posterior angles rounded, broadly and strongly biimpressed basally; base finely and completely margined; median line fine, much abbreviated; a faint trace of a median carina near the apex. Elytra two and one-half times the length of thorax, rather more than one-half longer than wide; sides distinctly convergent behind the middle; suture feebly elevated near the apex; apices feebly subtruncate, inner angles moderately rounded. Length, 10.25 mm.; width, 4.35 mm.

*Type.*—Female. Australia. Collection of the British Museum.

### PSEUDOMORPHA CHAMPLAINI, new species. (Schwarz Mss.)

Form strongly elongate, parallel, moderately convex. Color blackish piceous. Integuments not at all alutaceous, strongly shining throughout. Head and thorax moderately finely and not sparsely punctured; elytra punctured as given in the synopsis. Head scarcely more than one-half the width of thorax, less than twice as wide as long. Preocular lobes prominent, arcuate, oblique; clypeal suture not distinguishable. Antennae very long, considerably surpassing the anterior coxae. Thorax twice as wide as long; apex scarcely at all emarginate; sides strongly arcuate and rather strongly convergent anteriorly; posterior angles rounded; base not margined; a median fine line, abbreviated at either end, slightly impressed on the disk. Base slightly impressed either side; sides feebly explanate; side margins finely reflexed. Elytra as wide as thorax, two and one-half times as long, three-fourths longer than wide; sides parallel to near the apex; apices broadly subtruncate, suture feebly elevated close to the apex. Length 6.75—7.75 mm.; width, 2.75–3 mm.

*Male.*—Densely pubescent spots on the fourth and fifth ventral segments about one-seventh the width of the segment.

*Type.*—Male. Paradise, Arizona. (H. H. Kimball Coll.), Collection of the Bureau of Plant Industry, Harrisburg, Pennsylvania.

*Allotype.*—6,000 feet. Mount Washington, Nogales, Arizona, J. A. Kusche, July 1919–8. Collection of E. C. Van Dyke. *Paratype.*—(Male) California Collection of Chas. Schaeffer. Two paratypes (male) Oracle, Arizona, 7.7, 9.7. Two paratypes (male) Chiricahua Mountains, Arizona, 2.7, 4.7 (Coll. Hubbard and Schwarz). Collection of the United States National Museum. *Paratypes*, Cat. No. 26173, U.S.N.M.

### PSEUDOMORPHA SCHWARZI, new species

Form strongly elongate, parallel, moderately convex. Color dark rufous; elytra blackish piceous. Head, thorax, and elytra smooth, strongly shining, not at all alutaceous. Head and thorax with fine, rather sparse and indistinct punctures; the occipital transverse row of coarse punctures not so strongly developed; elytra punctured as given in the synopsis. Head slightly more than one-half the width of the thorax, less than twice as wide as long. Preocular lobes very prominent, strongly rounded, slightly oblique; clypeal suture indistinguishable. Antennae very long, surpassing considerably the anterior coxae. Thorax three-fourths wider than long; apex scarcely at all emarginate; sides feebly arcuate; basal angles rounded; base not margined; a fine feebly impressed subentire median line. Base transversely impressed laterally; sides scarcely explanate. Elytra two and one-half times the length of thorax, three-fourths longer than wide; sides parallel and straight to near apex; apices broadly, almost squarely truncate; suture not at all elevated. Length, 6.5 mm.; width, 2.5 mm.

*Male.*—Densely pubescent spots of the fourth and fifth ventral segments about one-seventh the width of the segment.

*Type.*—Male. Santa Rita Mountains, Arizona, June 16. (Coll. Hubbard and Schwarz.) Cat. No. 26174, U.S.N.M.

The following species of *Pseudomorpha* are identified in the material at hand:

### PSEUDOMORPHA PILATEI Chaudoin

Yucatan.—Coll. British Museum.

### PSEUDOMORPHA CRONKHITEI Horn

Tulare County, California.—Coll. C. Schaeffer.

### PSEUDOMORPHA BEHRENSI Horn

Walnut Creek, California, July 8, 1903. F. E. L. Beal. Bur. Biol. Surv.—Coll. U. S. N. M.

### PSEUDOMORPHA CASTANEA Casey

Stockton, Utah, July 23, 1903.—Coll. H. C. Fall.

Folsom, California, August 17, 1885 (Coll. Hubbard and Schwarz); Stockton, Utah, July 22, 1902; July 26, 1903.—Coll. U.S.N.M.

### PSEUDOMORPHA EXCRUCIANS Kirby

Covington, Louisiana, July 1, 1892 (Coll. Hubbard and Schwarz.—Coll. U.S.N.M.

### PSEUDOMORPHA LACORDAIREI Dejean

Brazil.—Coll. British Museum.

### PSEUDOMORPHA ANGUSTATA Horn

San Bernardino Ranch, Cochise County, Arizona, 3,750 feet, August, F. E. Snow; Baboquivaria Mountains, Arizona, F. E. Snow.—Coll. H. C. Fall.

Fort Grant, Arizona, Pinaleno Mountains, July 15, 1917 (2); near Kits Peak, Baboquivaria Mountains, Arizona, August, 7–9, 16.32° 0′ N., 111° 36′ W., about 3,000 feet.—Coll. E. C. Van Dyke.

Oracle, Arizona, 5.7, 6.7, 10.7, 23.7 (5) (Coll. Hubbard and Schwarz); Phoenix Arizona; Fort Grant, Arizona, 16.7 (2); 22.7 (2) (Coll. Hubbard and Schwarz); Santa Rita Mountains, Arizona, 18.6 (Coll. Hubbard and Schwarz); Deming, New Mexico, 22.7 (Coll. Hubbard and Schwarz); Morrison, Arizona (Coll. Hubbard and Schwartz); New Mexico, H. Ulke dedit.—Coll. U. S. N. M.

Arizona (Palm Coll.), Kits Peak, Rincon, Baboquivaria Mountains, Arizona, 1–4 August, 1916, 31° 57′ N., 111° 33′ W., about 4,050 feet (7) (at light); Black Dike, Prospect Sierritas, Arizona, July 26–29, 1916, 31° 56′ N., 111° 16′ W., about 3,750 feet (7) (at light); Deming, New Mexico, Luna County, July 12, 1917.—Coll. Amer. Mus. Nat. Hist.

Rincon Mountains, Arizona; Rincon Mountains, Arizona (5,000) (2); Rincon Mountains, Arizona, July, 1907 (4).—Coll. Notman.

## Genus HYDROPOROMORPHA Westwood

The species of this genus are altogether unknown to the writer except by the original descriptions. In conformity with the practice followed in the preceding genera, all the species in the following synopsis are marked with an asterisk to indicate that no specimens are at hand.

### KEY TO SPECIES OF GENUS HYDROPOROMORPHA WESTWOOD

1 Elytra pubescent ---------- * africana Schaufuss.
 Elytra not pubescent ---------- 2
2. Labrum not covering the mandibles. Antennae rather stout, with the joints oblong ---------- * westwoodi Raffray.
 Labrum covering the mandibles more or less completely ---------- 3

3. Antennae filiform, subsetaceous. Labrum more transverse. *** lutea** Westwood.
Antennae stout; joints 5–9 moniliform. Labrum about as long as wide------ 4
4. Form ovate. Disk of the thorax strongly sulcate. Elytra feebly striate. Size smaller, 3 mm------ *** monilis** Westwood.
Form longer and more parallel. Elytra with sides nearly straight. Thorax with disk feebly sulcate. Elytra more distinctly striate. Size larger, 4.5 mm------ *** obockiana** Fairmaire.

### Genus SILPHOMORPHA Westwood

The species of this genus seem especially difficult to separate. A specimen of *Silphomorpha difficilis* Blackburn which had been compared with the type was obtained through the kindness of G. J. Arrow, of the British Museum. Such other species as could not be identified in the material at hand are marked with an asterisk in the following synopsis. Complete description of none of the species has been attempted.

#### KEY TO SPECIES OF GENUS SILPHORMORPHA WESTWOOD

1. Thorax very wide, about three times as wide as long------ 2
Thorax narrower, about twice as wide as long------ 5
2. Thorax absolutely smooth------ 3
Thorax minutely punctate------ 4
3. Form broader. Elytra more shining. Striae more prominent apically. Thorax black------ *** laticollis** MacLeay.
Form less broad. Elytra less shining. Striae uniform. Thorax with piceous margins------ **froggatti** MacLeay.
4. Elytra with the striae strong------ **striatipennis** MacLeay.
Elytra with the striae nearly obsolete. Thoracic margins broader and piceous in color------ *** obsoleta** MacLeay.
5. Thorax larger, broader than the elytra------ *** denisonensis** Castelnau.
Thorax not broader than the elytra------ 6
6. Head larger. Its width about one-half the total length of the beetle. Eyes prominent------ *** boops** Blackburn.
Head smaller. From a third to a fourth the total length------ 7
7. Elytra very indistinctly striate------ 8
Elytra more or less strongly striate------ 16
8. Elytra absolutely smooth------ 9
Elytra punctate------ 13
9. Side margins of thorax and elytra paler, reddish------ *** laevis** Castelnau.
Side margins not paler------ 10
10. Form oblong. Thorax with the sides more arcuate. Beneath dark brown. Size large, 10 mm------ *** grandis** Castelnau.
Form oval. Thorax and elytra with sides more continuous. Underside more or less pale------ 11
11. Form more elongate. Size larger, 9 mm. Abdomen dark with apex broadly pale------ *** westwoodi**, new name.
Form short oval. Size smaller, 5–6 mm. Underside entirely pale castaneous------ 12

12. Elytra not paler at apex---------------------------- * **polita** Westwood.
(? **fugax** Westwood.)
Elytra with the apex rufescent. Thorax with the margins not explanate.
**difficilis** Blackburn.
(? **polita** Westwood.)
13. Elytra with a marginal series of a few strong punctures near the base.
* **laevigata** Castelnau.
Elytra minutely punctate---------------------------------------------- 14
14. Thorax alutaceous. Elytra with disk less densely punctate.
* **fugax** Westwood.
Thorax minutely punctate--------------------------------------------- 15
15. Elytra more distinctly punctate. Side margins not paler.
* **punctatissima** MacLeay.
Elytra very finely punctate. Side margins narrowly and abruptly paler.
* **amaroides** Newman.
16. Size larger, not less than 8 mm---------------------------------------- 17
Size smaller, not more than 7 mm----------------------------------------- 21
17. Thorax with side margins much wider in front---- * **tasmanica** Castelnau.
Thorax with side margins not distinctly wider in front---------------- 18
18. Thorax with side margins much narrower in front. Elytra very strongly striate------------------------------------------------ **striata** Castelnau.
Thorax with side margins not distinctly narrower in front------------- 19
19. Thorax and elytra with side margins paler, piceous. Thorax smooth. Elytra distinctly striate------------------------------- * **mastersi** Macleay.
Thorax and elytra with the side margins not paler-------------------- 20
20. Form broader. Elytra distinctly striate--------------- **vicina** Castelnau.
Form narrower, more parallel. Elytra with striate rather indistinct.
**fallax** Westwood.
21. Elytra with striae confined to apical portion---- * **semistriata** Castelnau.
Elytra with striae extending over median portion---------------------- 22
22. Form more oblong. Margins of thorax and elytra paler. Size larger, 7 mm------------------------------------------------ * **dubia** Castelnau.
Form more oval. Margins of thorax and elytra not paler. Size smaller, 5 mm------------------------------------------------- * **ovalis** Castelnau.

The following species of *Silphomorpha* are identified in the material at hand:

### SILPHOMORPHA FROGGATTI MacLeay

Laura (Lea) (2).—Coll. Amer. Mus. Nat. Hist.

### SILPHOMORPHA STRIATIPENNIS MacLeay

Port Darwin, Northern Territory (Lea).—Coll. Amer. Mus. Nat. Hist.

### SILPHOMORPHA DIFFICILIS Blackburn

Australia, 58,124.—Coll. Notman.

### SILPHOMORPHA STRAITA Castelnau

New South Wales (Hy Edwards Coll.).—Coll. Amer. Mus. Nat. Hist.

### SILPHOMORPHA VICINA Castelnau

New South Wales (Hy Edwards Coll.).—Coll. Amer. Mus. Nat. Hist.

### SILPHOMORPHA FALLAX Westwood

South Australia (Hy Edwards Coll.) (3); New South Wales, Australia (Edwards Coll.) (2); Mount Lofty, South Australia (Lea); Tintinara, under bark, July 1, 1887, Tepper (Lea).—Coll. Amer. Mus. Nat. Hist.

## Genus SPHALLOMORPHA Westwood

No new species could be distinguished in the material at hand in this genus and no complete descriptions are given. The species are somewhat more easily separated than in the other genera. In the following synopsis the species marked with an asterisk are those known from the original descriptions only, not being identified in the material at hand.

### KEY TO SPECIES OF GENUS SPHALLOMORPHA WESTWOOD

1. Color brilliant metallic green with purple or violet reflections. * speciosa Pascoe.
Color not brilliant metallic green ... 2
2. Elytra without discal or sutural maculae or vittae ... 3
Elytra with discal or sutural maculae or vittae ... 8
3. Elytra without basal and apical pale fasciae ... decipiens Westwood.
Elytra with basal and apical pale fasciae ... 4
4. Elytra finely rugose. Thorax entirely pale. Elytral fasciae wider. * flavicollis MacLeay.
Elytra smooth, shining ... 5
5. Lateral pale vittae of the elytra submarginal. Thorax black, with narrow piceous margin ... * marginata Castelnau.
Lateral pale vittae marginal ... 6
6. Thoracic disk entirely red ... nitiduloides Guérin.
Thoracic disk not entirely red ... 7
7. Thoracic disk red with two broad black vittae ... picta Castelnau.
Thoracic disk entirely black ... ornata MacLeay.
8. Elytra without discal maculae or vittae ... 9
Elytra with discal maculae or vittae ... 17
9. Elytra more smooth and shining, scarcely at all alutaceous ... 10
Elytra less shining, distinctly alutaceous ... 12
10. Elytra with a common basal pale reddish, triangular macula which includes scutellum ... * discoidalis Castelnau.
Elytra not thus maculate ... 11
11. Elytra with common, nearly round, pale macula on posterior half. * guttifera Castelnau.
Elytra with common macula median in position and produced in a point toward scutellum ... guttigera Newman.
12. Thorax very broad, about three times as wide as long. Elytra with common cordiform pale macula ... * cordifer Blackburn.
Thorax narrower, about twice as wide as long ... 13
13. Thorax and elytra with conspicuous pale margins ... 14
Thorax and elytra without or with very narrow pale margins ... 15

14. Elytra with a common sutural macula---------- **castelnaui** Reiche.
(**marginata** Castelnau.)
Elytra with an entire sutural vitta, somewhat expanded medially.
**suturalis** Germar.
15. Sutural macula nearly round. Form ovate---------- * **centralis** MacLeay
Sutural macula oval, more or less produced toward the scutellum---------- 16
16. Size larger, 9 mm. Sutural macula larger---------- * **maculigera** MacLeay.
Size smaller, 5 mm. Sutural macula smaller---------- * **thouzeti** Castelnau.
17. Thorax and elytra pale yellow with black maculae---------- * **amabilis** Castelnau.
Thorax and elytra in large part black or dark piceous---------- 18
18. Thorax and elytra without distinct pale margins---------- 19
Thorax and elytra with broad, distinct, pale margins---------- 24
19. Elytra with pale macula on each---------- 20
Elytra with oblique or curved vittae---------- 21
20. Elytra with a dull reddish margin. Form slightly broader.
**colymbetoides** Westwood.
Elytra without reddish margin. Form slightly narrower.
**bimaculata** Castelnau.
21. Elytra alutaceous, with large, pale macula occupying most of the disk, deeply emarginate toward the suture---------- * **spreta** Blackburn.
Elytra smooth, shining---------- 22
22. Elytra each with oblique, arcuate vitta, broader and somewhat hooked basally---------- * **bicolor** Castelnau.
Elytral vittæ not arcuate and hooked---------- 23
23. Elytra each with oblique vitta extending from base near the middle to suture, slightly behind the middle, forming a broad V.
* **rockhamptonensis** Castelnau.
Elytra vittae longer, extending nearly to elytral apices. Thorax unusually elongate. Elytra nearly as wide as long---------- * **macleayi** Masters.
24. Elytra each with one macula---------- * **albopicta** Newman.
Elytra each with two maculae or a vitta---------- 25
25. Elytra each with two maculae---------- 26
Elytra each with an oblique vitta---------- 27
26. Pale margins of thorax and elytra wider. Elytra more strongly alutaceous and less shining. Anterior maculae bifurcate posteriorly. Head larger. Size larger, 7–2.5 mm---------- **maculata** Newman.
Pale margins of thorax and elytra narrower. Elytra more shining. Anterior maculae produced posteriorly at their middle. Head smaller. Size smaller, 5.5 mm---------- **quadrimaculata** MacLeay.
27. Elytral vittae very broad, covering most of the elytra.
* **occidentalis** Castelnau.
Elytral vittae narrower, more or less dilated at the humeri---------- 28
28. Thorax with a median dark area---------- **hydroporoides** Westwood.
Thorax with a pale yellow median vitta---------- * **bivittata** Gestro.

The following species of *Sphallomorpha* are identified in the material at hand:

### SPHALLOMORPHA DECIPIENS Westwood

Victoria (2), Victoria, Austral (Edwards Coll.), South Australia (Lea) (2).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA NITIDULOIDES Guérin

Victoria, Austral. (Edwards Coll.), Victoria (2).—Coll. Amer. Mus. Nat. Hist.

Australia (Koebele).—Coll. United States Nat. Mus.

### SPHALLOMORPHA PICTA Castelnau

Port Denison, New South Wales, Austral.(Edwards Coll.) (2), New South Wales (Lea).—Coll. Amer. Mus. Nat. Mus.

### SPHALLOMORPHA ORNATA Castelnau

Cunnamulla, Queensland. H. Hardcastle (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA GUTTIGERA Newman

Victoria (2), Lucindale, South Australia (Feuerheerdt) (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA CASTELNAUI Reiche

Victoria, Victoria, Austral. (Edwards Coll.), Murray R., South Australia, H. S. Cope (Lea), Mount Lofty, South Australia (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA SATURALIS Germar

Victoria (3), Mount Lofty, South Australia (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA MACULIGERA MacLeay

Cairns Distr., E. B. Dodd (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA COLYMBETOIDES Westwood

South Australia (Hy Edwards Coll.) (2), South Australia (2), New South Wales, Australia (Edwards Coll.), Rainbow, Victoria (Lea), Nailsworth (?) (Holmes) (Lea).—Coll. Amer. Mus. Nat. Hist.

Australia (Koebele).—Coll. United States Nat. Mus.

### SPHALLOMORPHA BIMACULATA Castelnau

New South Wales, Austral. (Edwards Coll.).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA MACULATA Newman

South Australia (2), South Australia (Edwards Coll.).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA QUADRIMACULATA MacLeay

Townsville, Queensland. February 11, 1902, E. B. Dodd (Lea).—Coll. Amer. Mus. Nat. Hist.

### SPHALLOMORPHA HYDROPOROIDES Westwood

Victoria, Austral. (Edwards Coll.), Mount Lofty Rgs., S. H. Curnow (Lea) (5).—Coll. Amer. Mus. Nat. Hist.

## CATALOGUE

ADELOTOPUS Hope. 1834, Trans. Ent. Soc., London, vol. 1, pp. 11–12, pl. 1, fig. 1.

Tasmania, Australia, New Guinea, Java.

Monobasic, genotype, *A. gyrinoides* Hope, 1834.

*affinis* CASTELNAU. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 118.[7]

Sydney.

*analis* MacLeay. Trans. Ent. Soc., New South Wales, 1873, vol. 2, p. 95.

Gayndah.

*aphodioides* Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 404.

Adelaide.

*apicalis* MacLeay. Trans. Ent. Soc. New South Wales, 1866, vol. 1, p. 113.

Port Denison.

*bimaculatus* MacLeay. Trans. Ent. Soc. New South Wales, 1866, vol. 1, p. 113.

Port Denison.

=*rufoguttatus* Blackburn. Trans. Roy. Soc. South Australia, 1892–93, vol. 17, p. 295, See Blackburn, Trans. Roy. Soc. South Australia, 1901, vol. 25, p. 113.

Queensland.

*brevipennis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 459.

King's Sound.

*brunneus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 119.

Swan River.

*castaneus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 119.

Swan River.

*celeripes* Lea. Proc. Soc. Victoria, 1911, vol. 23, p. 120.

Western Australia: Swan River.

*cornutus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 177.

Arnheim's Land.

*dytiscoides* Newman. The Entomol., 1842, p. 365. Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 405, pl. 14, fig. 2.

Adelaide.

=*fortnumi* Hope. Trans. Ent. Soc. London, 1845, vol. 4, p. 105.

Adelaide.

*elongatulus* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 459.

Kings Sound.

*fasciatus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 118.

Sydney.

*filiformis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 119.

Adelaide.

*gyrinoides* Hope. Trans. Ent. Soc., London, 1834, vol. 1, p. 11, pl. 1, fig. 1 (details). Germar. Linn. Ent., 1848, vol. 3, p. 170. Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 403, pl. 14, fig. 1.

Port Phillip, Swan River.

=*paroensis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 117. See Gestro, Ann. Mus. Civ. Genova, 1884, vol. 20, p. 303.

Central Australia: Paroo and Darling Rivers.

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[7] This paper is published, probably as a separate, with a pagination of 1–139. The descriptions of the Pseudomorphidae are on pp. 25–34. The references in the Catalogus Coleopterorum of Gemminger and Harold are to this pagination.

*haemorrhoidalis* Erichson. Weigm. Archiv., 1842, vol. 1, p. 126. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 407, pl. 14, fig. 3 (Adelaide).
Van Dieman's Land.

var, *inquinatus*[8] Newman. The Entomol., 1842, p. 366.
South Australia: Port Phillip.

*hydrobioides* Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 406.
Melbourne.

*insignis* Sloane. Proc. Linn. Soc. New South Wales, 1910, vol. 35, p. 405.
Victoria: Sea Lake, Mallee District.

*jacobsoni* Ritsema. Notes Leyden, Mus., 1909, vol. 31, p. 255.
Western Java: Tandjong Prick.

*laevis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 460.
Kings Sound.

*linearis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 460.
Kings Sound.

*longipennis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 460.
Kings Sound.

*maculipennis* MacLeay. Trans. Ent. Soc. New South Wales, 1873, vol. 2, p. 95.
Gayndah.

*mastersii* MacLeay. Trans. Ent. Soc. New South Wales, 1873, vol. 2, p. 94.
Gayndah.

*micans* Blackburn. Trans. Roy. Soc. South Australia, 1901, vol. 25, p. 18.
South Australia: Quorn.

*nemosomoides* Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 408, pl. 14, fig. 4.
Adelaide.

*niger*, new species.
Australia.

*occidentalis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 117.
Swan River.

*papuanus* Gestro. Ann. Mus. Civ. Genova, 1893, vol. 33 (ser. 2, vol. 13), p. 287.
New Guinea: Ighibirei.

*politus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 117.
Brisbane: Clarence River.

*punctatus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 117.
Clarence River.

*puncticollis*, new species.
Victoria.

*rubiginosus* Newman. Trans. Ent. Soc. London, 1856, vol. 3, Proc. p. 128.
Without locality.

*scolytides* Newman. The Entomol., 1842, p. 366. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 408.
South Australia: Port Philip.

*serie-punctatus*, new species.
Victoria.

*tasmani* Blackburn. Trans. Roy. Soc. South Australia, 1901, vol. 25, p. 18.
Tasmania: Lake District.

*variolosus* Lea. Proc. Roy. Soc. Victoria, 1911, vol. 23, p. 121.
New South Wales: Sydney.

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[8] Though listed as a variety, there is nothing in the description by which to distinguish it from *A. haemorrhoidalis* Erichson.

*vicinus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 117.
Sydney.

*zonatus* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 118.
Melbourne.

CAINOGENION, new genus.
Genotype, (*Adelotopus*) *ipsoides* Westwood, 1837.
Australia.

*bicolor* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 120.
Victoria: Loddon River.

*creberrimum* (Blackburn). Trans. Roy. Soc. South Australia, 1901, vol. 25, p. 19.
South Australia: Basin of Lake Eyre

*cylindricum* (Chaudoir). Rev. Zool., 1862, ser. 2, vol. 14, p. 490.
Melbourne.

*ephippiatum* (Newman). Trans. Ent. Soc. London, 1856, vol. 3, Proc., p. 127.
Without locality.

*ipsoides* (Westwood). Trans. Linn. Soc. London, 1837, vol. 18, p. 413, pl. 28, fig. 2 (details). Germar, Lin. Ent., 1848, vol. 3, p. 170. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 405.
Adelaide.

*obscurum* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 120.
Sydney.

=*subopacum* (MacLeay). Trans. Ent. Soc. New South Wales, 1873, vol. 2, p. 94. See Gestro, Ann. Mus. Civ. Genova, 1884, vol. 20, pp. 302–303.

CRYPTOCEPHALOMORPHA Ritsema. Tijds, v. Ent., 1875, vol. 18, Verslag, p. xcii,
Siam, Java.
Monobasic, genotype, *C. gaverei* Ritsema, 1875.

*collaris* (Waterhouse). Trans. Ent. Soc. London, 1877, p. 2. See Ritsema, Notes Leyden Mus., 1909, vol. 31, p. 254.
Siam.

*gaverei* Ritsema. Tijds, v. Ent., 1875, vol. 18, Verslag, p. xciii.
Java: Batavia.

=*marginatus* (Waterhouse). Trans. Ent. Soç. London, 1877, p. 2. See Ritsema, Tijds, v. Ent., 1878–79, vol. 22, Verslag, pp. lxxxvii–lxxxviii
Java.

PAUSSOTROPUS Waterhouse. Trans. Ent. Soc. London, 1877, p. 3.
Monobasic, genotype, *P. parallelus* Waterhouse, 1877.

*parallelus Waterhouse*. Trans. Ent. Soc. London, 1877, p. 3.
Batchian.

PSEUDOMORPHA Kirby. Trans. Linn. Soc. London, 1825, vol. 14, p. 98.
America: Georgia to Argentina.
Monobasic, genotype, *P. excrucians* Kirby.

=*Heteromorpha* Kirby. Trans. Linn. Soc. London, 1825, vol. 14, p. 109. Monobasic, genotype, *H. excurcians* Kirby. Apparently a lapsus for *Pseudomorpha*.

=*Axinophorus* Dejean. Iconogr. Col. Fur., 1829, vol. 1, p. 174. Genotype, *A. lecontei* Dejean (=*P. excrucians* ?) by present designation.

=*Drepanus*[9] Dejean. Species Gen. Col., 1831, vol. 5, p. 434. Genotype, *D. lecontei* Dejean (=*P. excrucians* ?) designed by Hope 1838.

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[9] *Drepanus* Illiger 1807 (Mag. fur Insectenunde, vol. 6, p. 344) is a *nomen nudum*.

*angustata* Horn. Trans. Amer. Ent. Soc., 1883, vol. 10, p. 274, pl. 9, fig. 6.
Arizona.
*argentina* Steinheil. Atti Soc. Ital. Sc. Nat., 1869, vol. 12, p. 242.
San Luis,
*arrowi*, new species Mexico.
*behrensii* Horn. Trans. Amer. Ent. Soc., 1870, vol. 3, p. 76.
California.
*castanea* Casey. Can. Ent., 1909, vol. 41, p. 278.
Utah.
*champlaini*, new species California, Arizona.
*confusa*, new species. Australia.
*consanguinea*, new species. California, Arizona.
*cronkhitei* Horn. Trans. Amer. Ent. Soc., 1867, vol. 1, p. 151.
California.
*cylindrica* Casey. Ann. New York Acad. Sci., 1889, vol. 5, p. 40.
Texas.
*excrucians* Kirby. Trans. Linn. Soc. London, 1825, vol. 14, p. 101, pl. 3, fig. 3. Westwood, Trans. Linn. Soc. London, 1837, vol. 18, p. 411, pl. 28, fig. 1, and Rev. Zool., 1858, ser. 2, vol. 5, p. 395.
=*Axinophorus lecontei* Dejean. Dejean and Boisduval, Iconogr. Col. Eur., 1829, vol. 1, p. 176, pl. 19, fig. 2. Hope, Coleopt. Manual, 1838, pt. 2, p. 109.
=*Drepanus lecontei* Dejean. Spec. Gen. Col. 1831, vol. 5, p. 435.
Georgia. (?)
*falli*, new species. California.
*gerstaeckeri* Chaudoir. Bull. Moscou, 1877, vol. 52, pt. 1, p. 202.
Brazil: San Paulo.
*hubbardi*, new species Arizona.
*lacordairei* Dejean. Spec. Gen. Col., 1831, vol. 5, p. 436. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 396.
Brazil: Rio Janeiro.
*laevissima* Chaudoir. Bull. Moscou, 1852, vol. 25, pt. 1, p. 63.
Brazil: Novo-Friburgo.
*pilatei* Chaudoir. Rev. Zool., 1862, ser. 2, vol. 14, p. 490. Bates, Biol. Centr.-Amer. Col., vol. 1(1), p. 255, pl. 12, fig. 25.
Yucatan.
*schwarzi*, new species. Arizona.
*tenebroides*, new species. Arizona.
*van dykei*, new species Arizona.
*vicina*, new species California.
*vindicata*, new species. Utah.

HYDROPOROMORPHA Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 409. Raffray. Ann. Soc. Ent. France, 1885, ser. 6, vol. 5, p. 307.
Africa.

Monobasic, genotype, *H. lutea* Westwood. 1853.

*africana* (*Schaufuss*). Stettin. Ent. Zeitg., 1882, vol. 43, p. 308.
Abyssinia: Anseba.
*lutea* Westwood. Rev. Zool., 1853, ser. 2, vol. 5, p. 410, pl. 14, fig. 11.
Abyssinia.
*monilis* Raffray. Ann. Soc. Ent. France, 1885, ser. 6, vol. 5, p. 308, pl. 6, figs. 4 and 4*a*.
Abyssinia: Keren.
*obockiana* Fairmaire. Rev. d'Ent., 1892, vol. 11, p. 86.
Obock.

*westwoodi* Raffray. Ann. Soc. Ent. France, 1885, ser. 6, vol. 5, p. 309.
Abyssinia: Keren.

SILPHOMORPHA Westwood. Trans. Linn. Soc. London, 1837, vol. 18, p. 816.
Australia.

Monobasic, genotype, *S. fallax* Westwood. 1837.

*amaroides* (Newman). Trans. Ent. Soc. London, 1856, vol. 3, Proc., p. 127.
Without locality.

*boops* Blackburn. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 807.
South Australia: Northern Territory.

*denisonensis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 114.
Port Denison.

*difficilis* Blackburn. Trans. Roy. Soc. South Australia, 1901, vol. 25, p. 17.
New South Wales: Tweed River District.

*dubia* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 115.
New South Wales.

*fallax* Westwood. Trans Linn. Soc. London, 1837, vol. 18, p. 416, pl. 28, fig. 4 (details). Westwood, Rev. Zool. 1853, ser. 2, vol. 5, p. 396.
Australia.

=*orectochiloides* Hope. Trans. Ent. Soc. London, 1847, vol. 4, p. 104.
Adelaide.

*froggatti* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 457.
Kings Sound.

*fugax* (Westwood). Rev. Zool., 1853, ser. 2, vol. 5, p. 398.
Sydney.

*grandis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 114.
Port Denison.

*laevigata* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 116.
Victoria.

*laevis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 115.
Port Denison.

*laticollis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 457.
Kings Sound.

*mastersii* MacLeay. Trans. Ent. Soc. New South Wales, 1866, vol. 1, p. 112.
Port Denison.

*obsoleta* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 457.
Kings Sound.

*ovalis* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 116.
Queensland: Pine Mountains.

*polita* MacLeay. Trans. Ent. Soc. New South Wales, 1873, vol. 2, p. 93.
Gayndah.

*punctatissima* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser 2, vol. 3, p. 457.
Kings Sound.

*semistriata* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 115.
Port Denison.

*striata* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 114.
New South Wales: northern.

*striatipennis* MacLeay. Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 456.
Kings Sound.

*tasmanica* Castelnau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 115.
Tasmania.

*vicina* Castlenau. Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 114.
Brisbane.

*westiwood*, new name
=*laevissima* (Westwood). Rev. Zool., 1853, ser. 2, vol. 5, p. 497.
Morton Bay.

SPHALLOMORPHA[10] Westwood. Trans. Linn. Soc. London, 1837, vol. 18, p. 414.
Monobasic, genotype, *S. decipiens* Westwood. 1837.

*albopicta* (Newman). Zoologist, 1850, vol. 8, Append., p. cxxiv.
South Australia: Adelaide.

*amabilis* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 112. Blackburn, Proc. Linn. Soc. New South Wales, 1890, ser. 2, vol. 4, Append. p. 1246.
Port Denison.

*bicolor* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 111.
Rockhampton, Port Denison.

*bimaculata* (Castelnau). Trans. Roy Soc. Victoria, 1868, vol. 8, p. 112.
Rockhampton.
=*biplagiata* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 112.
Brisbane.

*bivittata* (Gestro). Ann. Mus. Civ. Genova, 1884, vol. 20, p. 302.
Port Denison

*castelnaui* (Reiche). Col. Hefte, 1868, vol. 3, p. 2, new name for *marginata* Castelnau, Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 112.
Melbourne, Sydney.

*centralis* (MacLeay). Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 458.
Kings Sound.

*colymbetoides* (Westwood). Rev. Zool., 1853, ser. 2, vol. 3, p. 403, pl. 14, fig. 10.
Adelaide.

*cordifer* (Blackburn). Proc. Linn. Soc. New South Wales, 1894, ser. 2, vol. 9, p. 86.
Queensland: northern, Cairns.

*decipiens* Westwood. Trans. Linn. Soc. London, 1837, vol. 18, p. 415, pl. 28, fig. 3 (details). Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 399.
Port Phillip.[11]

*discoidalis* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 112.
Murray River.

*flavicollis* (MacLeay). Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 458.
Kings Sound.

*guttifera* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 113.
Port Denison.

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[10] For the synonymy in this genus see Gestro, Ann. Mus. Civ. Genova, 1884, vol. 20, pp. 302, 303. For notes on distribution see Castelnau, Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 116.

[11] No locality is given with the original description.

*guttigera* (Newman). The Entomol., 1842, p. 367. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 398, pl. 14, fig. 4 (Adelaide).
South Australia: Port Phillip.

*hydroporoides* (Westwood). Rev. Zool., 1853, ser. 2, vol. 5, p. 401.
Adelaide.

*macleayi* (Masters). Proc. Linn. Soc. New South Wales, 1895, ser. 2, vol. 10, Suppl. p. 13, new name for *bivittata* (MacLeay). Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 5, p. 459.
Kings Sound.

*maculata* (Newman). Ann. Nat. Hist., 1840, vol. 4, p. 365. Germar, Linn. Ent. 1848, vol. 3, p. 171. Westwood, Rev. Zool. 1853, ser. 2, vol. 5, p. 401.
Adelaide.

=*quadrisignata* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 111.
Victoria, South Australia.

*maculigera* (MacLeay). Trans. Ent. Soc. New South Wales, 1866, vol. 1, p. 113.
Port Denison.

=*brisbanensis* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 113.
Brisbane, Port Denison, Clarence River.

*nitiduloides* (Guérin). Mag. Zool. 1844, ser. 2, vol. 6, pl. 140. *Pseudomorpha cinctipennis* Westwood, ms. olim. Westwood, Rev. Zool. 1853, ser. 2, vol. 5, p. 402, pl. 14, fig. 9 (Port Philip).
Poullaouen.

*occidentalis* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 113.
Swan River.

*ornata* (MacLeay). Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 458.
Kings Sound.

*picta* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 111.
Queensland: Northern, Rockhampton, Port Denison.

*quadrimaculata* (MacLeay). Trans. Ent. Soc. New South Wales, 1866, vol. 1, p. 113.
Port Denison.

*rockhamptonensis* (Castelnau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 113.
Rockhampton.

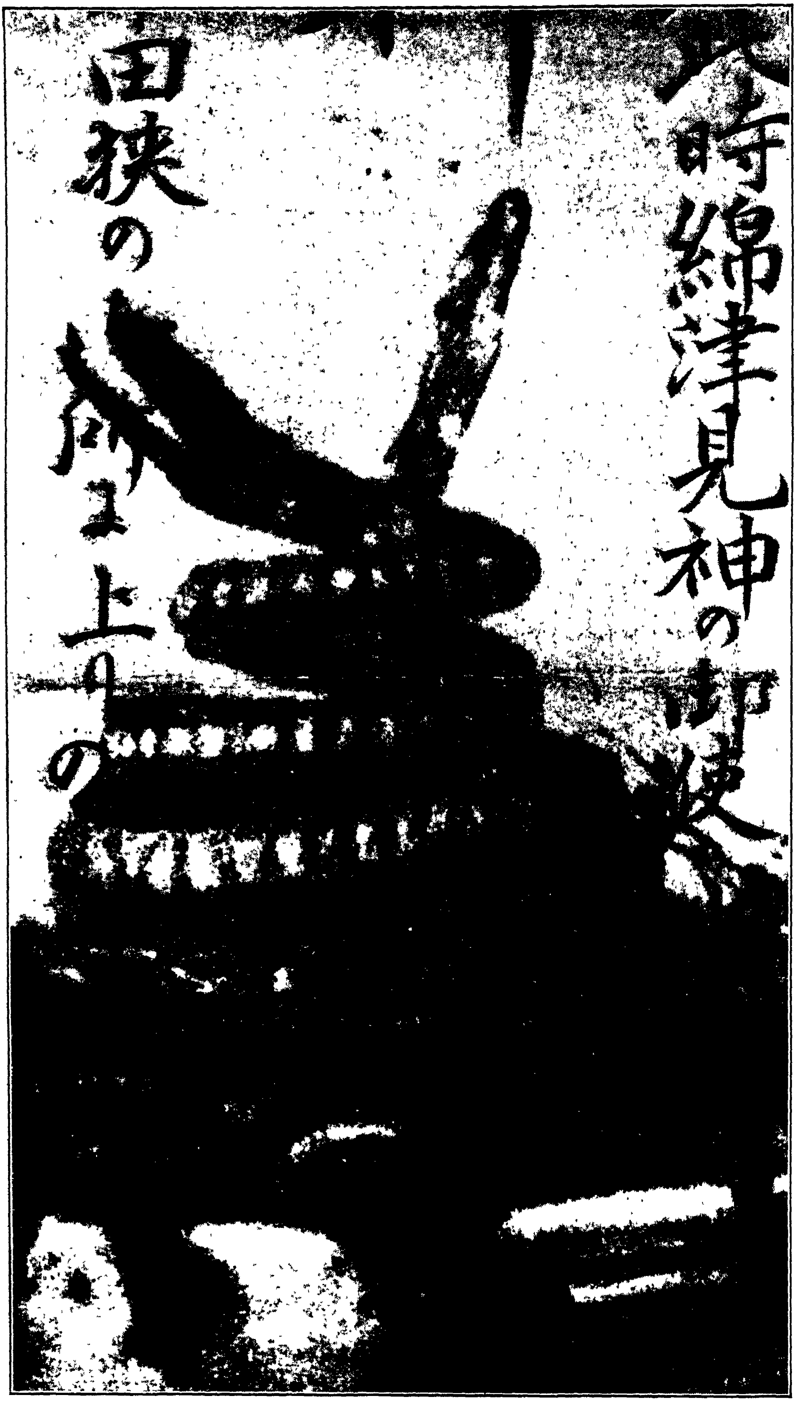
*speciosa* (Pascoe). Journ. of Ent., 1866, vol. 2, p. 26.
Queensland.

*spreta* (Blackburn). Proc. Linn. Soc. New South Wales, 1888, ser. 2, vol. 3, p. 805.
South Australia, Northern Territory.

*suturalis* (Germar). Linn. Ent., 1848, vol. 3, p. 171. Westwood, Rev. Zool., 1853, ser. 2, vol. 5, p. 400, pl. 14, fig. 6.
Adelaide.

=*rufomarginata* (MacLeay). Trans. Ent. Soc. New South Wales, 1873, vol. 2, p. 94.
Gayndah.

*thouzeti* (Castenau). Trans. Roy. Soc. Victoria, 1868, vol. 8, p. 113.
Rockhampton.



THE DRAGON GOD (DAI-JA) IN IDZUMO, JAPAN

FOR DESCRIPTION OF PLATE SEE PAGE 1

# THE DRAGON GOD (DAI-JA) IN IDZUMO, JAPAN. A JAPANESE TALE

By I. M. Casanowicz

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The Rev. J. C. Calhoun Newton, President Emeritus of Kwansei Gakuin, Union Methodist College at Kobe, Japan, in forwarding a photograph of the dragon to the National Museum, wrote to F. W. Hodge under date of April 27, 1921:

> * * * I am sending under another cover a description of the Dai Ja of Idzumo Shrine, an ancient serpent god of that place.
>
> Some time ago an enlarged photograph of this serpent god was entrusted to Bishop Walker R. Lambath, D. D., with the request that he deliver it to Doctor Hough, and will you kindly pass over to him the enclosed description of it. * * * [See plate.]

An abstract of President Newton's description as far as it bears on this serpent cult in Japan is as follows:

> Every year from ancient times all the gods in Japan assemble at "Amenohizuminomiya," in Idzumo Province, for the marriage conference. This is the reason why October is called in Japan, especially in Idzumo, the "Assembling Month of the Gods."
>
> In this month a sea-god named "Wadatsuminokami" sends a white serpent to the "Inasa Shrine" with his message. On his way the serpent is found by a certain devotee and taken into the shrine, where he is made for that year the pacifier of storms, fires, and floods.
>
> This legend is derived from the "Susano" mythology. Susanonomikoto, the son of Isanakinomikoto, after his father's death goes to Idzumo. This territory was possessed by an old man and his wife named "Ashinadzuchi" and "Tenadzuchi," at this time. A terrible eight-headed dragon lived there, and many young women were captured by him. So Susanonomikoto killed him by giving him a strong drink, in order to save the old couple, and then he married the daughter, named "Kushinada hime," of this old man and woman. * * *
>
> At the present day there are two "Shinto" shrines in Idzumo, the one, "Yaegaki Shrine," dedicated to Kushinada hime, the goddess of marriage, and the other, "Kitsuki," dedicated to "Okuninushi," son of Susano Mikoto, the god of fortune.
>
> Every year, from the 11th of October until the 17th, there is a great festival in these two shrines, and during those days there was once a dreadful storm in

this Province. The people ceased their house building, roof covering, entertaining, social gatherings, singing, playing on instruments, and all other kinds of business.

This probably came from the tradition of Susano mythology. While Susano was killing the Dragon for the old man and woman, they were watching it, staying near by until the awful monster was dead. In China and Japan there is a widespread tradition that such a dragon has something to do with a dreadful storm.

A fuller account of this story is given by Aston.[1]

> Susa no wo, the deity of rainstorm and brother of Amaterasu, the sun goddess, in coming on his wanderings to the province of Idzumo, he observed a chopstick floating down the river Hi, so thinking that there must be people living further up the stream, he went in quest of them, and found an old man and an old woman weeping, with a young maiden set between them. He asked of them, "Who are ye?" The old man replied, "Thy servant is a deity of earth, and his name is Ashinadzuchi, son of the great God of the Mountain. My wife's name is Tenadzuchi, and my daughter is called Kushinada hime." He further inquired, "Why weep ye?" He answered, saying, "I have had eight children, girls; but the eight-forked serpent of Koshi came year after year and devoured them. It is now the time of its coming, and therefore do we weep." "Describe to me this serpent," said Susa no wo. "Its eyes are as red as the winter cherry. It has one body with eight heads and eight tails. Moreover, its body is overgrown with moss, pines, and cedars. Its length extends over eight valleys and eight hills. Its belly is always all bloody and inflamed to look upon." Then Susa no wo said to the old man, "If this be thy daughter, wilt thou give her unto me?" "With reverence be it said," replied the old man, "I know not thy honourable name." "I am the elder brother of the Sun-Goddess, and have now come down from heaven," replied Susa no wo. Then the deities Ashinadzuchi and Tenadzuchi said, "In that case, with reverence we offer her to thee." Susa no wo straightway took that young maiden and changed her into a many-toothed comb, which he stuck into his hair, and said to the deities Ashinadzuchi and Tenadzuchi, "Do you brew some saké of eight-fold strength. Also make a fence round about, and in that fence let there be eight doors, at each door let there be eight stands, on each stand let there be a saké-tub, and let each saké-tub be filled with the saké of eight-fold strength. Then wait." So having prepared everything in accordance with his august bidding, they waited. Then the eight-forked serpent came, indeed, as had been said, and bending down one head into each of the tubs, lapped up the saké. Hereupon it became drunken, and all the heads lay down to sleep, when straightway Susa no wo drew his ten-span sword from his girdle and slew the serpent, so that the river had its current changed to blood. Now, when he cut the middle part of the tail the edge of his august sword was broken. Wondering at this, he pierced it and split it open, when he found that within there was a great sharp sword. He took this sword, and thinking it a wonderful thing, reported his discovery to the Sun Goddess. This is the great sword Kusanagi (Herb-queller).

Doctor Aston points out the striking resemblance of this story to that of Perseus and Andromeda, and quotes from Sydney Harland's "Legend of Perseus" (chapter viii),

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[1] W. G. Aston. Shinto: The Way of the Gods, 1905, p. 103f.

> that we have in this incident a reminiscence of the abolition of human sacrifices to deities in the shape of lower animals. * * * In certain stages of civilization, sacrifices of the kind are practiced, and are frequently offered to water-spirits conceived in animal form. * * * It may, of course, be that the monster sent to devour Andromeda is to be regarded simply as the personification of water or of specific rivers in their sinister aspect.

Doctor Aston adds then, concerning the dragon of the Japanese story:

> The circumstance that the scene of this episode in Susa no wo's career is the bank of a river is, therefore, by no means immaterial. Indeed, we may plausibly conjecture that the description of the serpent with its eight (or many) heads and eight tails, its length extending over eight valleys and eight hills, its body overgrown with moss, pines, and cedars, and its propensity for devouring human beings, is nothing more than a fanciful representation of the river, with its serpentine course, its tributaries and branches, its wooded banks, and the danger by drowning in its pools or at its fords.

The conception of a stream as a serpent or dragon, or one of these animals as the embodiment of a water-deity, is widespread. There is for the imagination a close nexus between a river and serpent. The sinuous, often winding and twisting course of the former and its mysterious movement without legs represents it to the fancy as a great, long-stretched serpent, while the beautiful wave-like motion of the latter and the water habitat of many of the species connects it with rivers and streams as the *genius loci*.

> Even in the Rig Veda there is deification of the cloud-snake. In later times they (the serpents) answered to the Nymphs, being tutelary guardians of streams and rivers.[2] The Arabs still regard medicinal waters as inhabited by *jinn*, usually of serpent form, [and] on the borders of the Arabian field we have the sacred fountain of Ephea at Palmyra, with which a legend of a demon in serpent form is connected.[3] A dragon's well is mentioned in Nehemiah II, 13, and a snake river in Josephus, Jewish War, V, 3, 2.

In the Babylonian creation myth the primeval watery chaos is symbolized by the monster Tiamat, and the conflict between Bel Marduk and Tiamat is a favorite theme of Assyro-Babylonian glyptic art. Tiamat is there pictured either as a composite dragon or—more rarely—as a long-stretched serpent. Thus on a cylinder seal in the Metropolitan Museum of Art in New York, a cast of which is on exhibition in the United States National Museum, Tiamat is represented as a large serpent with a peculiar horned head fleeing before Marduk, who pursues her with a sickle-shaped scimitar. The personification of the watery chaos by the dragon or serpent Tiamat may have been suggested to the Babylonian fancy by the waving billows of the agitated sea.

Reminiscences of the overthrow of Tiamat by the sun-god Marduk may be traced in the Old Testament where, of course, not Marduk, but the true God of Israel quelled and put to silence the evil dragon. Thus Isaiah LI, 9: "Art thou not it that cut Rahab and wounded the dragon." *Rahab*, which means raging, insolence, tumultuousness, is not unsuitable as a title of the chaos dragon, compare Isaiah XXX, 7. Psalm LXXXIX, 10: "Thou hast broken Rahab in pieces, as one that is slain." Job XXVI, 12: "He stilleth the sea with his power, and by his understanding he smiteth through Rahab," compare Job IX, 13. In all these passages Rahab is evidently an alternative for the Babylonian Tiamat and at the same time an emblematic synonym for Egypt. Isaiah XXVII, 2: "In that day the Lord with his sore (properly, hard) and great and strong sword shall punish leviathan the piercing (Revised Version, the swift, and margin, gliding or fleeing) serpent, and leviathan the crooked (Revised Version, margin, winding) serpent, and he shall slay the dragon that is in the sea." The three monsters in this passage are not unplausibly interpreted by some commentators (so, for instance, by Franz Delitzsch) as designating the three rivers, the Tigris, Euphrates, and Nile, and symbolic of Assyria, Babylonia, and Egypt, respectively, the three hostile powers of the world which were situated on these rivers. The "swift" or "fleeing leviathan" (compare the description of the Tiamat cylinder seal above) is a fit designation of the Tigris with its swiftly running course and rapids, whence its name, which is derived from old-Persian *tigra*, pointed, and *tigri*, arrow, characterizing it as darting or shooting forth like an arrow, compare Horace Odes IV, 14, 46: *rapidus Tigris.* Its Hebrew name, *hiddekel*, means sharp. The "crooked" or "winding leviathan" may well describe the Euphrates with its many windings and bendings; while the dragon, Hebrew, *tannin*, originally a personification of the sea or the floods, was subsequently applied to Egypt, compare Isaiah LI, 9; Ezekiel XXIX, 3.

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[2] E. W. Hopkins, The religions of India, 1895, p. 376, n. 3.

[3] W. Robertson-Smith, Religion of the Semites, 1889, p. 153f.

An instance in which a deity personifies the fructifying river Euphrates and is on this account denominated a serpent is found in an early Babylonian liturgy. Ninlil (also called Nintu and Nin Kharsag), spouse of Enlil, the supreme god of Nippur, who represents or symbolizes the female element of reproducing nature, is called serpent (Assyrian, *Sir*),[4] and the Euphrates itself was called the "river of the snake."

Finally, the symbol of representing the world under the form of a serpent biting its tail is explained from the fact that in the cosmogony of Egypt, Babylonia, Greece, and India, the earth was believed to be circumscribed by an ocean or "celestial river," whose circular course is compared to a serpent.

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[4] George A. Barton, Miscellaneous Babylonian Inscriptions, 1918, pp. 10, 41, 43, and 46, compare. J. P. Peters, Journal of the American Oriental Society, vol. 41, pp. 131 and following, especially pp. 142 and following.

# EGGS OF A NEW SPECIES OF NEMATOID WORM FROM A SHARK

By G. A. MacCallum
*Of Baltimore, Md.*

On July 6, 1924, we examined at the United States Bureau of Fisheries at Woods Hole, a large shark, *Carcharhinus commersoni*, and I found on the white under surface of the nose, in front of the mouth, a curious figure, which appeared like a drawing made with a fine pen with India ink. The figure was formed by a delicate tracery of lines extending over a patch about 2½ inches by 1½. We could not imagine why such a tracing should be there, and, as nothing of the particulars could be made out with the naked eye, I sliced off portions of the figure and placed them under the microscope was surprised to find that the lines were made up of black eggs laid in the grooves between the scales. We had never seen anything like it before and were at a loss to know what form could have laid them there, how it was done, and how they were kept in place and not swept away when the fish made its way through the water. Careful examination has failed to show any female worm which could have laid them.

Vertical and horizontal sections of the skin were made, after decalcifying the scales with hydrochloric acid, and in these the eggs were plainly seen to be those of some small worm, and attached to the grooves between the scales by some transparent, very adhesive glutinous material which surrounds them. They are dark brown, almost black, where the shell is thickest, and are of an elliptical form, measuring 0.10 mm. in length by 0.005 mm. in width. Anteriorly each has a closed orifice at the end of a short neck.

Dr. N. A. Cobb, who was kind enough to examine them, thought that they much resembled the eggs of *Trichocephalus dispar* in form, and later it was decided that they belong in all probability to a member of the genus *Capillaria*. Since it has been impossible to find the female worm that laid them, the question arises as to whether it may be that, as in the case of the common wild rat in which a nematode of this general type lays eggs in fine lines over the surface of the liver, the female after this is complete dies and disappears.

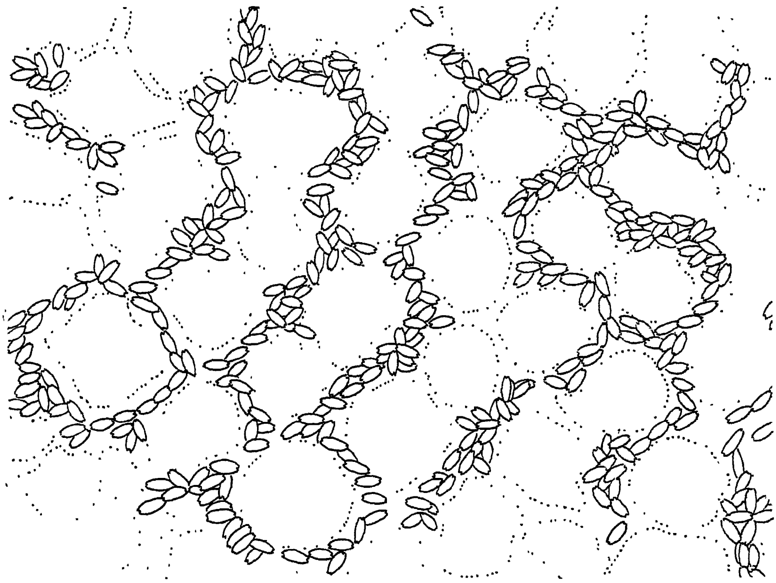
In another shark of the same species the same eggs were found in lines on the lighter colored portions of the anterior edges of the fins. Since they have not appeared in any other species of shark, I have named them as deposited by a member of the genus *Capillaria*, which should be called *Capillaria carcharhini*, new species. Although the other members of the genus are well known in other animals, this is possibly the only one recorded as having been found in a fish.

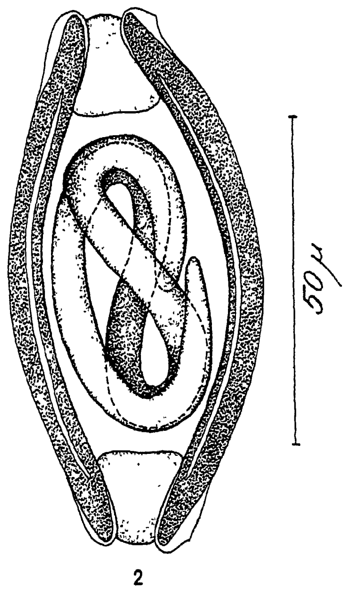
The type specimen has been deposited in the United States National Museum, Helminthological Collections under the number 7812.

## EXPLANATION OF PLATE

*Capillaria carcharhini*, new species

FIG. 1.—Portion of skin of shark with eggs of the parasite.
2.—Interior of egg showing embryo.
3.—Exterior of egg.





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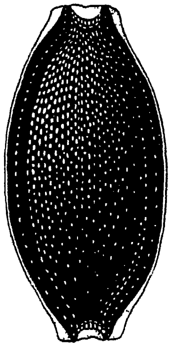

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Eggs of Capillaria carcharhini, new species

For explanation of plate see page 2

# TWO NEW LARVAL NEMATODES BELONGING TO THE GENUS PORROCAECUM FROM MAMMALS OF THE ORDER INSECTIVORA

By Benjamin Schwartz

*Of the Zoological Division, Bureau of Animal Industry, United States Department of Agriculture*

Under date of October 22, 1924, Dr. Paul Bartsch of the United States National Museum, forwarded to this laboratory encysted larval nematodes, collected by Miss F. A. Cook from under the skin of a short-tailed shrew (*Blarina brevicauda*) in the District of Columbia. The cysts are spherical in shape, from 2 mm. to 4 mm. in maximum diameter, each containing a spirally coiled nematode, visible through the rather transparent cyst wall. Two nematodes were freed from their cysts by dissecting the cyst wall and several cysts were cleared without injuring the cyst wall. Examination of the worms showed that though they were sexually immature, they could be readily identified as belonging to the genus *Porrocaecum*, on the basis of the oblong esophageal ventriculus, the absence of an esophageal appendix, and the presence of an intestinal cecum.

Owing to the feeble development of the lips and accessory mouth structures in the worms in question it is neither possible nor desirable to assign them to any of the known species of the genus, and following a common usage among zoologists, these parasites, though sexually immature and otherwise incompletely developed, are given specific rank, the name *Porrocaecum encapsulatum* being proposed for them.

### PORROCAECUM ENCAPSULATUM, new species

Immature worms, occurring in globular cysts from 2 mm. to 4 mm. in maximum diameter, lodged under the skin of the host. The worms are long, slender, superficially resembling filaria, lying spirally coiled within their cysts (fig. 8). The cuticle is striated transversely throughout the entire length of the worms. One specimen extracted from the cyst measures 36 mm. in length by 0.365 mm. in maximum width. The head when viewed from the side shows two small cuticular protuberances (fig. 7) whose morphological nature appears uncertain. When viewed *en face*, three feebly developed lips surrounding a small opening, the mouth, and what appear to be six rather large papillae could be made out. The esophagus consists of two portions, namely (*a*) the muscular esophagus proper and (*b*) the ventriculus (fig. 6). The esophagus proper is filariform in shape, its diameter increasing in the posterior portion. In one specimen the esophagus is 1.2 mm. long by 125μ in maximum width in the region of the base, and 62μ in minimum width just below the head. In another specimen the maximum width of the esophagus is 178μ. The ventriculus is oblong in shape (fig. 6) from 223μ to 232μ long by 125μ to 178μ wide. The intestinal cecum (fig. 6) is long and slender and lies alongside the esophagus. The distance from the top of the intestinal cecum to the base of the ventriculus, slightly below which the former originates, is 630μ and 756μ respectively, in two specimens examined. The intestine terminates at a distance of 133μ from the posterior extremity (fig. 5) and has a more or less uniform diameter, which measures 115μ in the region of the middle of the body. In the anal region a number of structures presumably glands, stand out rather prominently. The tail (fig. 5) ends in a spinose tip which measures about 25μ in length. No opening of the reproductive system or any evidence of the presence of gonads could be distinguished in the specimens examined.

*Host.*—*Blarina brevicauda.*

*Location.*—Under the skin.

*Locality.*—District of Columbia.

*Type specimens.*—United States National Museum, Helminthological Collections No. 26052.

On June 27, 1923, Dr. E. A. Chapin of this bureau discovered an encysted nematode under the skin in the costal region of a mole (*Scalopus aquaticus*), that had been trapped at Falls Church, Virginia. On July 10, 1923, Doctor Chapin found another encysted nematode under the skin of the same species of mole, trapped in the same locality. Doctor Chapin freed these larvae from the cysts and identified them as belonging to the genus *Porrocaecum*, basing his generic determination on the structure of the esophagus and on the presence of an intestinal cecum. One specimen was evidently lost or destroyed. The second specimen was returned to Dr. N. A. Cobb of the Bureau of Plant Industry, to whom the material in question belonged and to whom the present writer is indebted for the privilege of studying it. The present writer is also indebted to Doctor Chapin who furnished information concerning the location of the cysts in the host and the appearance of the larvae within the cysts.

An examination of Doctor Cobb's specimen showed it to be an immature *Porrocaecum* considerably smaller than *Porrocaecum encapsulatum*, the mouth structures being, however, somewhat more developed than those in the latter species. The larval nematode from the mole (*Scalopus aquaticus*) is quite distinct from the form found in the shrew (*Blarina brevicauda*) and is described as a new species, the name *Porrocaecum americanum* being proposed for it.

### **PORROCAECUM AMERICANUM, new species**

The worm in its preserved state has been removed from its cyst, and is coiled in a loose spiral, having the shape of the figure 6 (fig. 3). Doctor Chapin states that the worm in its encysted condition was tightly coiled, completely filling its capsule. The specimen is 7.9 mm. long and 225µ wide in the middle of the body. The cuticle is cross striated throughout the entire length of the specimen, the striations in the middle of the body being approximately 15µ apart, the distance between the striations diminishing as the two extremities are approached. The mouth structures are more developed than those of *Porrocaecum encapsulatum*, the three lips (fig. 2) appearing as distinct and well-defined structures, the dorsal lip being larger than the two lateral lips. In lateral view, cuticular prominences, such as those in *Porrocaecum encapsulatum*, are not distinguishable. The esophagus (fig. 4) consists of two parts, namely, the esophagus proper and a ventriculus. The former is about 690µ long and the ventriculus which is oblong in shape is 133µ long by about 80µ in mamimum width. The nerve ring is located at a distance of 178µ from the anterior extremity. The intestinal caecum (fig. 4) is 440µ long and lies alongside the esophagus. The intestine whose diameter is more or less uniform, measuring about 80µ in the middle of the body, terminates at a distance of 107µ from the posterior extremity (fig. 1). The tip of the tail (fig. 1) is apparently broken off as the posterior extremity of the specimen has a truncate appearance that suggests an artifact. No evidence of a genital opening or of gonads could be found in this specimen.

*Hosts.*—*Scalopus aquaticus.*

*Location.*—Under the skin.

*Locality.*—Falls Church, Virginia.

*Type specimen.*—United States National Museum, Helminthological Collections No. 26060.

## EARLIER REPORTS OF ENCYSTED NEMATODES IN INSECTIVORA

The first record of the occurrence of encysted nematodes in Insectivora was published by Goeze (1782), who found some spirally coiled worms inclosed in cysts and lodged in the peritoneal cavity of a European mole, presumably *Talpa europaea.* The worms which have the shape of the figure 8 as they lie in the cyst are described and figured by Goeze, who recognized their ascarid structure and placed them in the genus *Cucullanus.* The specific name *Cucullanus talpae* was proposed for these parasites by Schrank (1788). Zeder (1803) named them *Fusaria incisa* and Rudolphi (1802) called them *Ascaris incisa,* by which name they have been commonly known to helminthologists. Leuckart (1842) records encysted larval nematodes from the abdominal cavity and liver of the European shrew (*Sorex tetragonurus*) similar to and possibly identical with *Ascaris incisa.* Leuckart's specimens are from 10 mm. to 18 mm. long, whereas *Ascaris incisa* is only from 8 mm. to 10 mm. long according to various observers. Without expressing any definite opinion, Leuckart considers the possibility that the forms from the shrew are distinct from *Ascaris incisa* and proposes the tentative name *Ascaris acanthura* for his specimens. According to Seurat (1916) *Spiroptera strumosa* Mégnin (1881) is synonymous with *Ascaris incisa* Rudolphi (1802). Under the name *Spiroptera strumosa* Mégnin records encysted nematodes from the surface of the stomach and intestines of a European mole. This writer finds that although these cysts are six times as large as Trichinae cysts, they have been mistaken for the latter. Baylis (1924) expresses the opinion that encysted nematodes from small mammals, such as shrews, belong to the genus *Porrocaecum.* This opinion is apparently based on Leuckart's idea that *Ascaris incisa* is a larval stage of *Ascaris depressum* (*Porrocaecum depressum*).

The two species of *Porrocaecum* larvae described in this paper are related to the various forms described from Europe, but they differ from the latter as regards location, occurring subcutaneously, whereas the European specimens have been recorded from the abdominal cavity. *Ascaris incisa,* is in all probability, a group name, similar to *Ascaris capsularia,* a collective name including various agamic nematodes encysted in fishes. According to Seurat's diagnosis (1916) *Ascaris incisa* occurs in branching cysts, the capsules being multiple and connected to each other by peduncles given off from the cyst wall. This is borne out by Leuckart's figures of *Ascaris incisa* (Leuckart, 1876). Mégnin's figure of *Spiroptera strumosa* likewise shows a pedunculated cyst. Goeze's figures of *Cucullanus talpae,* and Leuckart's figures of *Ascaris acanthura,* which he considered as probably identical with *Ascaris incisa,* show nonpedunculated cysts, from which it may be concluded that under the name *Ascaris incisa* two or more species are probably included.

*Porrocaecum encapsulatum* differs strikingly from all previously described nematode larvae from Insectivora in size, since it is four times as long as *Ascaris incisa* and twice as long as the longest specimens of *Ascaris acanthura. Porrocaecum encapsulatum* is tightly coiled, the comparatively large number of coils filling the cyst completely, whereas *Ascaris incisa* assumes the shape of the figure 6 or 8 within the cyst, the interior of the latter being but partially filled by the parasite. *Ascaris acanthura* has a shape more or less resembling the figure 8, and only partially fills the cyst, so far as can be judged from Leuckart's figure. The species from the mole described in this paper (*Porrocaecum americanum*) is similar in size to *Ascaris incisa*, but in view of the fact that the latter appears to be a group name, and that a precise account of its morphology has not been published, it is more desirable not to add to the already existing confusion, and accordingly the form from the American mole (*Scalopus aquaticus*) may best be considered distinct from that from the European mole (*Talpa europaea*).

## THE GENUS PORROCAECUM RAILLIET AND HENRY 1912

The genus *Porrocaecum* is included in the family Ascaridae, and according to a recent revision of this family by Baylis (1920), it is assigned to the subfamily Anisikinae Railliet and Henry, 1921, emended by Baylis, 1920. Baylis defines the genus *Porrocaecum* as follows: "Esophagus with anterior muscular portion and posterior ventriculus of oblong shape, the latter short in the genotype, but in other species frequently long and bent at an angle so as to open into the intestine laterally. An intestinal cecum present. No esophageal appendix. Interlabia present, usually small dentigerous ridges present." Fifteen species belonging to this genus are listed in the catalogue of the Zoological Division of the Bureau of Animal Industry, the hosts being fishes, amphibia, birds, and marine mammals. At least one species (*Porrocaecum crassum*) is probably of economic importance, since it occurs in ducks. It is not improbable that further investigations will add to the number of species of *Porrocaecum* on the one hand and subtract from it on the other hand. Only five species listed under this genus are regarded by Baylis (1920) as probably belonging to it, while the same writer regards certain species from fish with a type of alimentary canal characteristic of the genus, but not as yet included in it, as requiring further investigation. It may be concluded, therefore, that our knowledge of the genus is as yet incomplete, and that further investigation will probably result in bringing to light additional species which may lead to a new conception regarding the affinities of the various members now included in it.

## LIFE HISTORY OF SPECIES OF PORROCAECUM

Our present knowledge of the life history of species of *Porrocaecum* is very fragmentary, the essential facts being understood in only two species, so far as the present writer has been able to ascertain. In the case of *Ascaris decipiens* (=*Porrocaecum decipiens*) of the Alaskan seal, the source of infection with this parasite according to Stiles and Hassall (1899) is to be found in certain fish that constitute part of the food of the definitive host. Stiles and Hassall (1899) say that immature ascarids, representing various stages intermediate between the adult forms of *Ascaris decipiens* and the so-called *Ascaris capsularia*, which is a collective name applied to larval nematodes found encysted in various species of fish, occur in the stomach of seals, and that this suggests that these animals acquire the infection with *Porrocaecum decipiens* as a result of eating infected fish. Although Stiles and Hassall did not carry out any feeding experiments, they report finding encysted ascarids in the Alaskan pollock and the Pacific cod, which were identical with the youngest forms, presumably of *Porrocaecum decipiens*, found in seals. Since these fishes are known to be eaten by seals, Stiles and Hassall conclude with a fair degree of certainty that the definitive host acquires the infection as a result of eating the intermediate host. So far as concerns *Ascaris incisa* it was suggested by Leuckart (1876) that it is the larval form of *Ascaris depressa* (=*Porrocaecum depressum*), a nematode that occurs in various birds of prey such as hawks and owls. Leuckart's view has been commonly accepted by helminthologists, although no experimental evidence has been obtained to prove this relationship.

The occurrence of encysted Porrocaecum larvae in mammals suggests a relationship between the intermediate and the unknown definitive hosts similar to that described by Stiles and Hassall (1899) for *Porrocaecum decipiens*. The unknown definitive hosts in the cases reported by the present writer and by others are in all probability birds, presumably hawks and owls, and other flesh-eating birds. Two species of *Porrocaecum* from hawks are represented in the Helminthological Collections of the United States National Museum. One species is from *Circus hudsonicus* and the other is from *Falco columbarius*, both from Fishers Island, New York. The form from *Circus hudsonicus* has a very small intestinal cecum. An American species of *Porrocaecum* is described by Smith, Fox, and White (1908) as *Ascaris ardea* (=*Porrocaecum reticulatum*) according to Baylis and Daubney (1922), from a North American blue heron (*Ardea herodias*). Smith, Fox, and White fail to mention the ventriculus and the esophageal bulb. Baylis and Daubney (1922) are convinced, however, that the species described by Smith, Fox, and White is a synonym of *Ascaris reticulata* von Linstow 1899 (=*Porrocaecum reticulatum*). According to the former writers this species has a well-developed intestinal cecum and a less conspicuous ventriculus, which they describe as short and oblong. While the larval forms described by the present writer have a well-developed intestinal cecum, they also have a conspicuous ventriculus, and are therefore probably not identical with *Porrocaecum reticulatum*. However, as already stated elsewhere in this paper, the immaturity of the present writer's specimens does not warrant comparison with any known adult forms.

The determination of the adult stages of *Porrocaecum encapsulatum* and *Porrocaecum americanum* must await the examination of probable definite bird hosts in the vicinity of the District of Columbia and Virginia for parasites of the digestive tract, and the experimental infection of birds with *Porrocaecum* as a result of feeding them encysted larvae from intermediate hosts.

## SUMMARY

Two encysted larval nematodes occurring in Insectivora are described for the first time from the United States, and are definitely shown to belong to the genus *Porrocaecum*. These forms appear to be related to encysted nematodes described from moles and shrews in Europe under the name *Ascaris incisa* and under other names, but are distinct from the European forms as regards location in the host as well as regards certain morphological characters. *Porrocaecum encapsulatum* described in this paper from the shrew (*Blarina brevicauda*) is strikingly larger than any of the related forms heretofore known, and *Porrocaecum americanum* from the mole (*Scalopus aquaticus*) though agreeing in size with *Ascaris incisa* is considered distinct, because the latter is probably a group name and has been incompletely described, so that there exists no definite basis on which to make morphological comparisons.

The adult forms of the larvae here described (*Porrocaecum encapsulatum* and *Porrocaecum americanum*) probably occur in birds of prey, such as hawks and owls. Owing to the incomplete state of development of these larvae, particularly as regards the mouth parts, it is impossible to compare them to any advantage with adult specimens of *Porrocaecum* collected from American birds of prey. The ultimate solution of the question of the adult stages of the larvae described in this paper will have to be based on more complete knowledge of the species of *Porrocaecum* that occur in American birds of prey and on feeding experiments.

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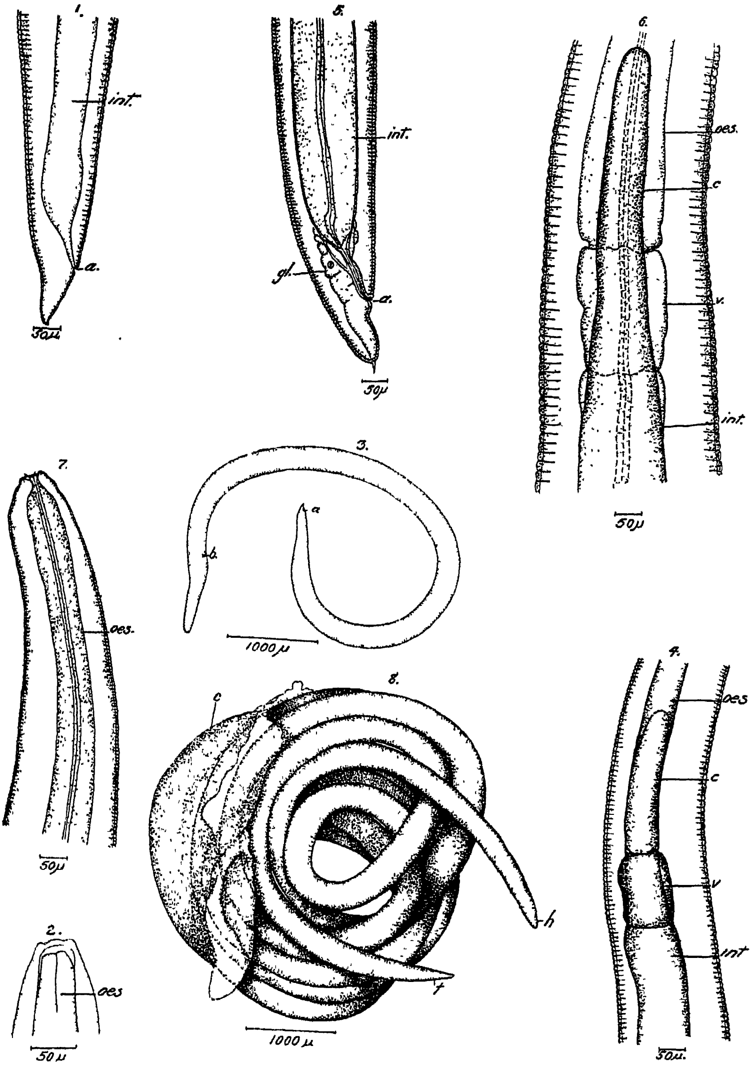
## EXPLANATION OF PLATE

*a.*—anus.
*b.*—base of esophagus.
*c.*—intestinal cecum.
*gl.*—glands.
*h.*—anterior extremity.
*int.*—intestine.
*oes.*—esophagus.
*t.*—posterior extremity.
*v.*—ventriculus.

Figs. 1–4.—*Porrocaecum americanum*, new species (lateral views). 1, posterior end; 2, anterior end; 3, outline drawing of entire worm; 4, esophageal region.

Figs. 5–8.—*Porrocaecum encapsulatum*, new species (lateral views). 5, posterior end; 6, esophageal region; 7, anterior end; 8, encysted worm with cyst partially removed to show the worm.



NEW LARVAL NEMATODES OF THE GENUS PORROCAECUM

FOR EXPLANATION OF PLATE SEE PAGE 8

# OCCURRENCE OF THE CRINOID GENUS APIOCRINUS IN AMERICA

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By Frank Springer,
*Associate in Paleontology, United States National Museum*

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The genus *Apiocrinus* is one of the most conspicuous of Mesozoic crinoids, hitherto known only from Europe, where it is found as a typical fossil in the upper Jurassic (Oolite) of England, France, and Switzerland. It was first described and figured by Parkinson[1] under the name "Pear Encrinite," in allusion to the pronounced pear shape of the calyx. In 1820 Schlotheim designated Parkinson's species according to the rules of binomial nomenclature as *Encrinites parkinsoni*, nearly all crinoids then being known as *Encrinites.*

In the following year J. S. Miller in his Natural History of the Crinoidea, 1821, proposed the genus *Apiocrinus* for the Parkinson fossil, to which he gave a new specific name, *A. rotundus;* this was not accepted because clearly a synonym of Schlotheim's species. Thus the name became established as *Apiocrinus* (*Apiocrinites*) *parkinsoni* (Schlotheim) for the species by which the genus is best known in collections, through specimens from the Bradford clay of England, and from various localities in England and France. The genus is abundant and widely distributed, 27 species having been described, 15 from France, 2 from England, and 10 from Switzerland and adjacent regions. The descriptions of most of them may be found in the works of D'Orbigny, Quenstedt, and De Loriol.

*Apiocrinus* is the type of a very distinct family which has continued from the Jurassic to the present time; and the genus itself, in its typical forms, is strongly differentiated from its fellows by the fact that the stem, which is round and without cirri, is in its upper part greatly expanded into a proximal conical enlargement continuous with the sides of the calyx, so that there is no line of demarcation between them. Its characters in detail are well shown in the figures of *A. parkinsoni* in Zittel–Eastman's Text-book of

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[1] Organic Remains of a Former World, 1808, vol. 1, p. 208, pl. 16, figs. 1–8, from Bradford, near Bath, England.

Paleontology[2]; while the general aspect of the fossil is illustrated on page 231 by their copy of D'Orbigny's restoration, incorrect as to cirri, of his well known species, *A. roissyanus;* also in Dana's Manual of Geology.[3]

While remains of five other important European Mesozoic genera, *Pentacrinus*, *Isocrinus*, *Balanocrinus*, *Bourgueticrinus*; and *Marsupites*, have been identified in America, the extremely prolific *Apiocrinus* has remained until this time unrepresented in the western hemisphere. I am now able to announce its addition to the list.

In March, 1923, Mr. W. S. Adkins brought into the United States National Museum in Washington a series of fossils collected by him in the course of geological investigations for the Cia. Mexicana de Petroleo "El Aguila" on the isthmus of Tehuantepec, Mexico. Among them were a number of crinoid stem-fragments which were submitted to me for examination. Some of these were in the matrix, a pinkish limestone, and others loose. They were derived from a limestone outcrop on the east bank of the Rio Playas at a point 10.8 kilometers south and 3.9 kilometers east of the northeast corner of the Limantour property, near the junction of the rivers Playas and Potrero Nuevo. The horizon was identified by Mr. Adkins, on the strength of the other fossils, as upper Jurassic or lower Cretaceous, probably the former, which the evidence of the crinoids confirms.

The crinoid stems are in small sections, none of them containing more than eight or ten columnals. In several the joint-faces are well exposed, and inspection of them at once eliminated *Pentacrinus* and *Balanocrinus* from consideration, while it disclosed a similarity of type to the joint-faces of *Apiocrinus*, which was confirmed by the presence of a single piece containing five columnals having the characteristic expansion of the stem proximal to the calyx. This left no doubt as to the generic affinity of the fossils, thus establishing for the first time the existence of *Apiocrinus* in the rocks of the American continent. While the material is too imperfect for close specific discrimination, the occurrence is of sufficient interest paleontologically to warrant the designation of a new species, for which I propose the name—

### APIOCRINUS TEHUANTEPEC, new species

There are about 20 stem-fragments, similar in appearance and evidently belonging to the same species; all are round, and without trace of cirri, the largest about 10 mm. in diameter. The tapering specimen is the most characteristic. Its five columnals have a total length of 13 mm., and during that interval it enlarges from 7 mm. to 10. The joint-face is marked by about 56 fine radiating striae running inward from the periphery to a smooth ring surrounding the lumen, about one-third the diameter of the columnal and flush with the adjacent surface; this is seen in several specimens, and is evidently a constant character, with perhaps some variation in relative diameter.

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[2] 1913 edition, pp. 230, 231.

[3] Fourth edition, p. 778.

In the structure of the joint-face may be seen the decisive difference between this genus and *Pentacrinus*, *Isocrinus*, or *Balanocrinus*, the other forms which might be encountered in rocks of the same age. In these the joint-face is divided into five petaloid sectors differing among the genera, the first two having short crenelations at the margin of the sectors, and the last having them only at the periphery of the stem. In *Apiocrinus* there are no sectors, and the striae extend directly inward for about one-third to two-fifths the diameter of the joint, or perhaps sometimes all the way to the lumen. For convenience of comparison with the *Apiocrinus* joint-face, and also to facilitate identification of fragments that are likely to be found, I am giving characteristic figures of the other two types (pl. 1, figs. 8, 9, 10, 11). The smooth ring surrounding the lumen is a marked character in our species, occupying about one-third the diameter of the joint, probably varying in different parts of the stem; it is but little, if any, sunken below the general surface of the joint, and the striae in some cases pass over it.

Among European species comparison may be made with *Apiocrinus elegans* (Defrance), which is of a very similar type to our species, having usually less curvature to the sides of the expanded stem than in such characteristic species as *A. parkinsoni* and *A. roissyanus*. *Apiocrinus elegans* was described by Defrance in 1819[4] as *Astropoda*, and in 1839 was referred by D'Orbigny to *Apiocrinus*.[5] The species is widely distributed, and occurs at many localities in France, especially in the districts of Calvados, Cote d'Or, Nievre, etc. It has been thoroughly described and figured by De Loriol,[6] from whom I am giving copies of his figures 1, 4, and 6 of plate 34, showing the contour of stem and calyx, and figures 4, 4*b*, 4*c* of plate 35, giving details of the joint-face.

In relative proportions of the corresponding parts there is little difference between our species and this. In the 5 columnals of ours the spread in diameter is as 1 to 1.4; in De Loriol's figures of *A. elegans* on plate 34 for the same number of columnals the spread in figure 4 is as 1 to 1.5, and in figure 6 as 1 to 1.6. The joint-face as shown by figures 4, 4*c* of plate 35, has a somewhat less number of striae, about 48, and a similar smooth median ring, which is relatively larger and distinctly sunken. This smooth inner ring surrounding the lumen seems to be a constant feature in *Apiocrinus*, as well as in some other genera, as for instance, *Proisocrinus* A. H Clark[7] a Recent member of the same family. It varies from strongly marked and deeply sunken to flush with the rest of the surface. So far as can be ascertained, it seems to be most marked at the top of the stem just beneath the conical enlargement, gradually becoming less marked and finally obliterated below. The flush surface of the inner ring resembles the same structure in *Apiocrinus polycryphus*, as shown by De Loriol on plate 36, figure 4*a*. In comparing the figures of De Loriol which I have copied with those of our species, it must be remembered that while the former are natural size, the latter are one and a half times enlarged.

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[4] Dict. des Sci. Nat., vol. 14, p. 468.

[5] Hist. Nat. des Crinoides, p. 29, pl. 5, figs. 9–15.

[6] Crinoides de la France, vol. 2, pt. 1, 1883, p. 240, pls. 34, 35.

If we had the calyx of our species greater differences might be found. In such a great distance migrational changes are likely to occur. On the other hand, there are crinoid species of intercontinental distribution, for example *Pentacrinus subangularis*, one of the best known European species, of Jurassic age, which has been found in Alaska, with characters so nearly identical that only varietal differences, if any, can be pointed out. And even among existing crinoids, although rarely, an equal extension of range may be found, as in the case of *Rhizocrinus lofotensis*, which occurs from Florida to Greenland and eastward to Norway.

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[7] Proc. U. S. Nat. Mus., vol. 38, 1910, p. 390, fig. 3.

## EXPLANATION OF PLATE

### APIOCRINUS TEHUANTEPEC, new species

**Fig. 1.** Fragment of stem containing conical enlargement proximal to the calyx, tapering for a distance of 5 columnals from 7 mm. diameter to 10 mm. × $\frac{3}{2}$.

**2 and 3.** Stem fragments of larger individuals from more distal parts of the stem. × $\frac{3}{2}$.

**2*a* and 3*a*.** Joint-faces of the same specimens, slightly frayed at the periphery, having about 56 striae, which extend inward for about two-fifths of the diameter to a smooth inner ring surrounding the lumen. × $\frac{3}{2}$. Collection United States National Museum. Upper Jurassic, Isthmus of Tehuantepec, Mexico.

### APIOCRINUS ELEGANS (Defrance)

Upper Jurassic, Bathonien. Calvados, France

**Figs. 4, 4*b*, 4*c*.** Joint-faces and lateral view of isolated stem fragments, showing the radiating striae, and smooth sunken inner ring. After De Loriol, Pal. France, vol. 11, pt. 1, pl. 35, figs, 4, 4*b*, 4*c*. Natural size.

**5, 6, 7.** Different forms of calyx and conical stem enlargement. After De Loriol, pl. 34, figs. 1, 4, 6. Natural size.

### PENTACRINUS SUBANGULARIS, var. ALASKA Springer

Lower Jurassic. Northern Alaska

**Figs. 8, 9.** Two joint-faces, showing petaloid sectors with crenellae at their margin. Natural size. Collection United States National Museum.

### BALANOCRINUS MEXICANUS Springer

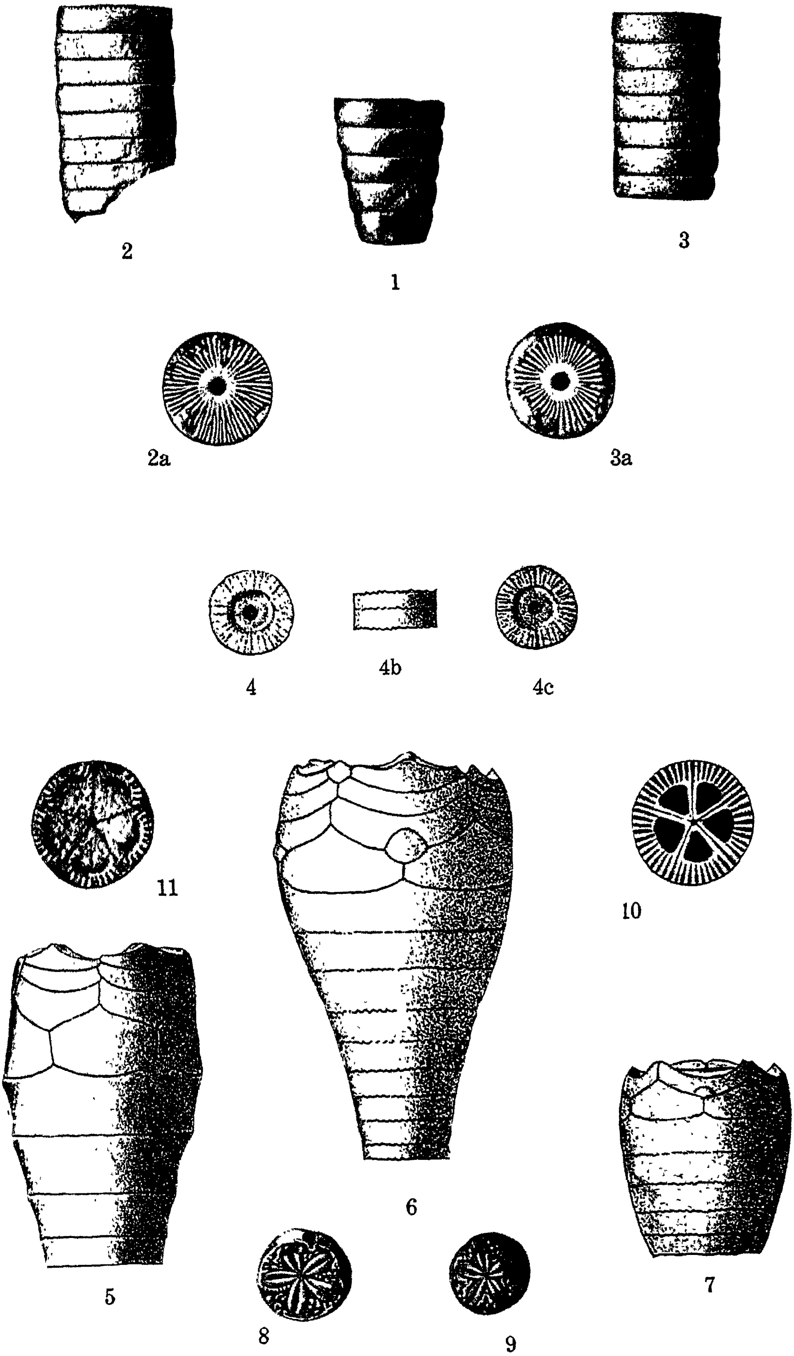
Upper Cretaceous. Tamaulipas, Mexico

**Fig. 10.** A joint-face, showing petaloid sectors with crenellae at periphery of the joint. × $\frac{3}{2}$. Collection United States National Museum.

### BALANOCRINUS HAITIENSIS Springer

Tertiary, Miocene. Republic of Haiti

**Fig. 11.** A joint-face, showing petaloid sectors, with shorter peripheral crenellae. × 2. Collection United States National Museum.



APIOCRINUS AND OTHER CRINOID GENERA

FOR EXPLANATION OF PLATE SEE PAGE 5

# THE ADAPTIVE MODIFICATIONS AND THE TAXONOMIC VALUE OF THE TONGUE IN BIRDS

By Leon L. Gardner,
*Of the United States Army Medical Corps*

Since the work of Lucas[1] there has been little systematic investigation on the tongues of birds, and with the exception of an occasional description the subject has been largely neglected. It is in the hope of reopening interest in the subject that this paper is written.

As is well known the tongue is an exceptionally variable organ in the Class Aves, as is to be expected from the fact that it is so intimately related with the birds' most important problem, that of obtaining food. For this function it must serve as a probe or spear (woodpeckers and nuthatches), a sieve (ducks), a capillary tube (sunbirds and hummers), a brush (Trichoglossidae), a rasp (vultures, hawks, and owls), as a barbed organ to hold slippery prey (penguins), as a finger (parrots and sparrows), and perhaps as a tactile organ in long-billed birds, such as sandpipers, herons, and the like.

The material upon which this paper is based is the very extensive alcoholic collection of birds in the United States National Museum, Washington, D. C., for the use of which and for his abundant aid in numberless ways I am very much indebted to Dr. Charles W. Richmond, associate curator of the Division of Birds. To Dr. Alexander Wetmore, assistant secretary in charge of the United States National Museum, I wish to express my thanks for his kind assistance in reviewing the paper and for his help in its preparation.

Part of the material is from my own collection which is now filed with the Museum and which came to me in many ways. Dr. Witmer Stone, director of the Academy of Natural Sciences of Philadelphia, furnished me with much from foreign sources for which I am greatly

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[1] Lucas, F. A. The Taxonomic Value of the Tongue in Birds, The Auk, vol. 13, No. 2, April, 1896, pp. 109–115.

Lucas, F. A. The Tongues of Woodpeckers. Bulletin No. 7, U. S. Department of Agriculture, Division of Ornithology and Mammalogy.

Lucas, F. A. (1897). The Tongues of Birds. Report of U. S. National Museum, 1895, pp. 1003–1020.

No. 2591.—Proceedings U. S. National Museum, Vol. 67, Art. 19.

indebted. J. Eugene Law, Altadena, Calif., provided me with much valuable fresh material, as did also George Willett, Los Angeles, Calif., to both of whom I wish to express my thanks.

Finally I am much indebted to Prof. Charles F. Baker, Los Banos, Philippine Islands, for his assistance, and to my wife for her aid in the preparation of the illustrations.

Before reviewing the variations undergone by the tongue a brief consideration of the histology may be of interest to throw some light on the function.

### ANAS PLATYRHYNCHOS

A cross section through the anterior one-third of the tongue reveals the following: The section is very irregular in shape, with a deep groove dorsally. In the center of the tongue is the single cartilaginous and bony mass of the fused ceratohyals. Surrounding this is a complex interlacing of adipose and connective tissue, stratified skeletal muscle, blood vessels, and nerve trunks. Embedded deeply in tissue are found groups of mucous glands, ducts of which here and there can be traced to the dorsal surface of the tongue. Dorsolaterally is seen a double row of cornified spines or hairs, from the base of which strands of cells are scattered deeper into the tongue. Small nerve corpuscles are seen grouped chiefly about the cornified spines. Finally the surface of the tongue is composed of stratified epithelium through which ducts of mucous glands pass.

### TYTO PRATINCOLA

The extreme tip of the tongue is composed almost entirely of cornified epithelium. Posterior to this on section the tongue is concave dorsally, the epithelium covering this surface being a relatively thin layer. The center of the tongue is occupied by the bony mass of the ceratohyals surrounded by connective tissue with interlacing fibers of striated muscle. At the mid point between the tip and posterior margin of the tongue mucous glands make their appearance, and from this point posteriorly become abundant.

The glands in this species are quite superficial, being embedded in the layer of stratified epithelium itself and opening to the surface through pores which are visible, with the unaided eye or a small lens, on gross inspection. Nerve corpuscles are either absent in this species or very infrequent.

### PICA NUTTALLI

On section the tongue is concavo-convex, with the concavity representing the dorsal surface. The ventral surface is composed of cornified epithelium. The dorsal surface is covered with a deep layer of noncornified stratified epithelium. Glands in this species do not appear except at the extreme posterior portion of the tongue. Nerve corpuscles are infrequent.

### CARPODACUS MEXICANUS FRONTALIS

The section is cordiform in shape. The ventral and lateral surfaces are covered with thin cornified epithelium. The dorsal surface is composed of a thick knoblike mass of stratified squamous epithelium through which no glandular ducts were seen to pass. Several large nerve trunks pass through the length of the tongue beneath the branches of the ceratohyals. Nerve corpuscles are found in the posterior end of the tongue.

It is apparent even from such a brief survey that the tongue must serve, in part in some species at least, as an accessory salivary gland. In addition tactile sense must be ascribed to it, if not even that of taste, as Botezat[2] suggests.

The variations found in bird tongues are very extensive and often complex.

Embryological study shows that this organ in birds is primitively a paired structure arising from the second and third visceral arches. This paired condition reflects itself in the hyoid bones, the two foremost of which, the ceratohyals, being typically unfused and embedded in the flesh of the tongue itself. Posterior to this paired position is a median unpaired tract, the basihyal. Upon this foundation are constructed all the elaborate variations to be found among the tongues of birds. Thus the tongues of woodpeckers, which at first sight seem to be constructed on a wholly different pattern than that of a robin, are, on last analysis, seen to be but an extensive modification of this rather primitive type, the ceratohyals being fused to a small spearlike tip and the basihyal greatly elongated. This is represented superficially by the small barbed sharp tip, the true tongue, while behind this is the fleshy cylindrical extensive basihyal portion often spoken of as the tongue.

As Lucas[3] pointed out in his work, the tongue of a robin (fig. 1) serves as a ground pattern for many modifications. In this bird it is a slender, horny, lanceolate organ, wider and fleshier at the base than the tip and narrowing to the tip, which is translucent, cornified, somewhat split and frayed, with a tendency to curl.

Posteriorly the tongue ends in a free edge which is deeply concave, with the concavity looking caudad and armed with many sharp conical spines which are firm in texture but bend readily. Laterally, the tongue ends in two main branches, tipped with heavy spines many times larger than the marginal spines. In this type of tongue there is a definite line of demarcation between the fleshy body of the tongue and the translucent cornified tip which is frayed.

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[2] Botezat, E. Die sensiblen Nervenendapparate in den Hornpapillen der Vögel in Zusammenhang mit Studien zur vergleichenden Morphologie und Physiologie der Sinnesorgane, Anat. Anz., vol. 34, 1908.

Botezat, E. Die sensiblen Nervenendapparate und die Geschmacksorgane der Vögel. Vortrag, gehalten auf der 77. Vers. der Naturf. u. Aerzte in Meran 1905. Referat in den Verhandlungen der Gessellschaft.

Botezat, E. Morphologie, Physiologie und phylogenetische Bedeutung der Geschmacksorgane der Vögel. Anatomischer Anzeiger, vol. 36, 1910, pp. 428–461.

[3] Lucas, F. A. The Tongues of Birds. Rep. U. S. Nat. Mus., 1895, pp. 1003–1020.

In studying such a tongue for factors that are constant, one is forced to conclude that beyond the general shape and appearance there is nothing that can be accepted as invariable. The number of posterior spines is inconstant within the species, although they may be counted on to be in a single row (in contradistinction to the multiple rows as seen in owls, for example).

The length depends on the amount of wear. In a series of meadowlark tongues collected in one day in South Dakota the length varies from 16 mm. to 20.5 mm. The birds were feeding almost entirely on grasshoppers that were at that time a serious pest.

The main posterolateral or heaviest spines are not invariable in arrangement; while always present they may be bifid or in birds, as some of the sparrows, where they are normally split into two, there may be three or four subdivisions.

The curling, splitting, and fraying is also variable within the species and shows individual modifications, although, as will be seen later, these characters serve as very important adaptive features and undergo extensive variations in certain families.

Bearing in mind these inconstant factors it is of interest to trace the modifications that may be found of this fundamental pattern.

With slight differences in curling, splitting, length, and arrangement of spines this tongue is to be found in a large number of passerine birds, as the warblers, vireos, thrushes, thrashers, crows, flycatchers, shrikes, wrens, bulbuls, drongos, and the like, with *Glareola* closely simulating it. The divergence from the type, however, is most marked and comes to its greatest development in the flower-frequenting forms.

The typical tongue has an inherent tendency to curl, split, and fray, and any one or all of these tendencies may be combined to make up the tongues of the flower frequenters.

Thus splitting alone with little tendency to curl and no fraying is exemplified by the tongue of the flowerpeckers or Dicaeidae, which is deeply split, forming very slender long forked tips, two in *Dicaeum* and four in *Prionochilus*.

On the other hand marked curling is seen in the Old World sunbirds (Nectariniidae), where it may be a complete tube for the greater part of its length, without fraying of the margins of the tube and with splitting into two tips either absent or very slight. Whether the tongue be a relatively short one, as in *Hermotimia* (fig. 141), or very long as in *Arachnothera*, this perfect tubular arrangement exists in the anterior two-thirds of each. Splitting is not present in some individuals, or if present is not very deep, although *Anthreptes* is rather deeply cleft, forming two fringeless tubes.

Curling and fraying of the lateral margins is illustrated by the Drepanididae. In *Hemignathus* (fig. 19), *Himatione*, *Chlorodrepanis*, *Vestiaria*, and *Heterorhynchus* it is long and slender, curled into a complete tube, the edges of which are delicately frayed, with the tip ending in a much frayed but not bifid brush.

Finally, beginning with *Dendroica tigrina* (fig. 2), an interesting series of *split* and *frayed* tongues can be demonstrated. In this warbler the maximum of curling in the Mniotiltidae is reached, Baird [4] going so far even as to suggest a separate genus for it.

From this it is a near step to the curled tongues of *Zosterops simplex* and *Z. japonica*, which are described by Beddard [5] as being curled into almost a complete tube with a much frayed tip.

The next step can be traced through the Icteridae, where in *Icterus* (fig. 3) it is curled, in the anterior one-third to one-half, with elaborately frayed edges and somewhat split to form two semitubular fringed tips. The Coerebidae carry this still further. *Glossoptila* (*Euneornis*) makes no advance, with only moderate curling, splitting and fraying at the tip. *Chlorophanes* (fig. 4) is curled in the anterior one-half and is split and frayed, but the tongue is not yet tubular nor has it reached that stage in *Cyanerpes.* But in *Diglossa* and *Coereba* (fig. 5) it is found to have become a complete tube by the overlapping of the upcurled edges and the splitting involves the entire anterior one-half of the tongue, so that, instead of one, we find two complete tubes highly fringed and frayed. Finally this splitting has reached its maximum in the Meliphagidae, so that in *Myzomela rubratra* (fig. 6) it has become a completely curled tongue in the anterior half, splitting into four tubular frayed tips.

The examples might be unnecessarily multiplied. Suffice it to say that such a study brings to light a most interesting series of elaborately modified tongues, the exact correlation of diet with which offers material for future study.

Returning to the ground pattern we can see a close resemblance between it and the tongues of some of the motmots and todies (see fig. 74), in which birds it is rather flat and the thin horny translucent tip constitutes as much as one-half of the organ.

A curious little variation is seen in the titmice (see fig. 123). In these birds the cartilaginous tips of the ceratohyals project through the tip of the tongue and with two lateral projections form what has been likened to a four-tined pitchfork. The nuthatches (fig.

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[4] Baird, S. F. Review of American Birds, November, 1864, pp. 161–162.

[5] Beddard, F. E. Ibis, ser. 6, No. 3, 1891, pp. 510–512, Tongue of *Zosterops*.

121) modify this by having six or seven tangled tips well calculated to collect small insects and spider eggs from the crevices of tree bark.

Such, in brief, is a survey of the modifications of the type pattern seen among birds. There are, however, many tongues that are apparently fashioned on other foundations. Among these are found many of the shore and water birds. Thus the tongue of a gull (fig. 28) (*Larus*) might be selected as a type. In these forms, according to Giebel,[6] the ceratohyals tend to fuse into one bone. Superficially one sees this manifested by a rather fleshy organ which, while having a median depression or groove running the length of the tongue, still has no tendency to curl and, while often very slightly incised or frayed at the tip, is not split to any degree. Such a tongue, varying in length and breadth, is to be found in a large series of rails, sandpipers, terns, plovers, and the like.

Some interesting adaptations are to be noted especially among the fish feeders. If the tongue is edged laterally with sharp spines for one-half or more its length we would have it as seen in the petrel tribe, fulmars (fig. 25) and shearwaters; loons (fig. 23) modify the pattern by concentrating all the spines in one large sharp patch posteriorly. Finally if this process is continued so that the whole surface of the tongue is covered with retroverted spines we would have the condition as represented by the penguins.

Another ground pattern is seen among the woodpeckers (fig. 13). As has been noted the basihyal has been greatly lengthened in these birds whereas the ceratohyals are fused as a small conical tip. The true tongue then is represented by the sharp horny white tip armed with lateral, backwardly directed spines, while behind this is the long extensile wormlike basihyal portion which, when drawn back into the mouth, inverts and forms a sheath into which the rest of the organ can be retracted. This portion is covered with minute spines scarcely visible to the unaided eye, the apparent function of which is to hold the saliva, which is especially abundant in these birds. This pattern is characteristic of the family Picidae and is seen in no other forms.

An odd pattern is assumed by the Ardeidae (figs. 31–34) in which it is long, fleshy, and cylindrical, the characteristic feature being, however, the absence of sharp spines at the posterior margin of the tongue. Instead is found only a soft, fleshy flap, somewhat serrated in outline, ending laterally in large but flexible tips.

Among the Anatidae (fig. 9) again this organ assumes a characteristic appearance undergoing many interesting variations to be described later.

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[6] Giebel, C. Die Zunge der Vögel und ihr Gerüst, Zeitschr. für die Gesammten Naturwiss., vol. 11, 1858, pp. 19–53.

Hawks, owls, and vultures have powerful rasping tongues, a structure that does not seem to be based primarily on the fundamental pattern. For in most of these birds the ceratohyals, according to Giebel,[6] are fused the greater part of their length except at about the mid point, where by reason of failure of fusion a hole is left.

Parrots display an individuality of their own. In many of these birds the tongue is broader at the tip than at the base, forming almost a finger, with the anterior margin convex. It may be flat, cupped, grooved, rolled into a tube, or even brush-tipped (figs. 70–73).

Finally, without considering the various rudimentary tongues there are a host of odd types scattered throughout the class Aves, such as the curious feathered tongues of the toucans (fig. 87); that organ as found in the puff-birds (fig. 83), the cuckoos, the flamingoes, and the like. One is constantly impressed with the fact that no reliable guess as to the tongue form can be made by the appearance or function of the bill and that any generalization is a very uncertain procedure.

The color of the tongue is interesting only in passing. Usually flesh colored, it may not be so, however, often taking the color of the bill or assuming a color of its own. Thus it is black in the crow and its allies; has brown spots in some swallows; may be entirely black with white spines in that odd cuckoo, the road-runner (*Geococcyx californianus*), or be almost entirely flesh-colored, mottled with black, in other members of the same species. It is pink in the red-billed Heermann gull (*Larus heermanni*). It is said to be scarlet in the black cockatoo. Still again a light blue is seen. Some of the hawks, as the marsh hawk (*Circus hudsonius*), have the posterior end and the spines this color.

Out of this confusing multiplicity of form it seems possible to make certain groupings as to function and adaptation. And if this is done one finds approximately eight natural groups are formed:

1. An omnivorous diet is productive of a rather generalized pattern. This includes the great majority of tongues found in the Passeriformes, as has been described. The chief adaptive feature lies in the presence of the posterior marginal spines. The tongue is capable of being depressed at the tip and elevated posteriorly. When worked rapidly backward and forward it can be used to force resistant food down the throat. The efficacy of this is most astonishingly manifest if, for instance, a bit of cloth be fed to a nestling. In such an instance it is only with difficulty that the cloth can be withdrawn from the throat without injury to the bird, so eagerly is the tongue with its spines used to resist the effort.

In this group falls also the simple fleshy tongues of the gallinaceous birds (fig. 7).

2. Fish eaters, where the tongue is used to hold slippery prey. In these it is found to be plentifully supplied with sharp, stiff retrorse spines. These may be distributed over the whole surface, as in the penguins, edging the lateral margin only as in the fulmars and shearwaters (fig. 8), as a patch of stiff spines situated at the base, as in the loons, or a double row on the surface, as in mergansers (fig. 10). A distinction must be drawn between fish eaters that use the tongue and those in which the food is bolted whole, where it has lost its function and a different condition prevails.

3. A diet of a multiplicity of small things strained from the water is associated with the complex tongues of the Anatidae (fig. 9).

Typically it is roughly rectangular in shape and is thick and fleshy. The tip is composed of a cornified rounded flaplike process. Posterior to this the tongue is broad with a median groove and provided laterally with a double row of heavy hairs, the upper overhanging the lower like a thatched roof. Toward the posterior half the upper row, by a process of agmination of the hairs, becomes converted to a series of large, heavy spines, which vary in number with the different species. Coincidentally the edges of the median groove become cornified with rough, toothlike processes. Lateral to these the surface of the tongue is nodular or papillar and plentifully supplied with openings of ducts of muscous glands. The posterior portion of the tongue is made up of a fleshy eminence heavily armed with strong spines.

The method of use is interesting. The tongue is depressed, allowing water to run along the groove, it is then raised against the palate, the water squirted out from the sides through the hairy edges, straining out and leaving the solids.

Considerable variation is seen, depending on the use of this organ and the width of the bill. Thus in the geese and swans where it is used for tearing up weeds and grasses it has become a very powerful tearing structure. In *Cygnus buccinator*, for example, the edges of the median groove instead of consisting of rather rounded eminences become very sharp, long tearing spines.

A similar purpose is accomplished by *Branta nigricans* by conversion of the entire lateral row of hairs into spines; in other words, all of the lateral hairs have become agglutinated into spines, and this process extends quite to the tip.

On the other hand the red-breasted merganser (fig. 10), having taken to fish fare, has developed sharp dorsal spines and lost one row of marginal hairs, tending to approach in type the fish eaters.

4. Flesh feeders or the birds of prey, including the owls, have developed heavy rasping tongues. The anterior portion is often very rough and hard and in some forms somewhat curled as in eagles and lammergeiers. The posterior spines, which may be in a single or multiple row, are stiff and hard. Opening to the surface are ducts of many mucous glands the function of which is manifest. A curious modification of form is seen in the deep trough-shaped tongues of the vultures and the condor, which are armed with sharp marginal spines (figs. 36–43).

5. Where the food is probed for and consists largely of insects we see the structure as exemplified by woodpeckers. Lucas[7] has demonstrated an interesting correlation with diet. Flickers (fig. 14), having made a departure from the regular fare and having taken to an ant diet, are found to possess a blunt-tipped tongue with but two or three reduced barbs, while the extensibility is greatly increased and the whole dorsal tract (basihyal position) plentifully supplied with minute spines to hold mucous. In these birds also the submaxilliary salivary glands reach their maximum development, a combination well adapted to catch ants.

In *Melanerpes* (fig. 15), where the diet has become more generalized, it will be found that the extensibility is reduced and instead of spines at the tip there has been a conversion to vibrissae or hairlike processes.

Finally in the sapsuckers (fig. 16) the extensibility is reduced to a minimum. The dorsal tract is bare of spines except posteriorly, where it is widened into a shieldlike structure bearing papillae. At the tip and along the lateral edges there is a fine brush of hairs which serves well for capillarity but is ill adapted to spearing grubs nor are many of these found in an analysis of stomach contents.

Among this group should be classed the spearing and impaling organs of the titmice, and nuthatches, already described.

6. Seed and nut eaters have fleshy and strong tongues. In this group are to be classed those of the typical parrots (fig. 17) and finches (fig. 18). In parrots it has been described. In finches it is cylindrical or tends toward that form and slopes from base to tip. Since the ability of a bird to project the lower mandible is very limited the rolling of seeds in the act of husking would be difficult. With the inclined surface of the tongue, however, acting as a surface against which seeds may be rolled, this is actually accomplished most dexterously. In many finches for reasons not entirely understood the tongue is often scoop-shaped or even rolled into a semitubular structure, as will be illustrated later.

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[7] Lucas, F. A. The Tongues of Woodpeckers. Bull. No. 7, U. S. Dept. of Agriculture, Div. Ornith. and Mammalogy.

7. Flower frequenters (fig. 19) have most complex tongues. Among these we find the fringed split and tubular tongues of the Drepanididae, the Nectariniidae, Dicaeidae, some of the Icteridae, the Zosteropidae, and the Meliphagidae. In this group also falls the Trochilidae. Finally a most remarkable adaptation is found in the flower frequenting parrots of the family Trichoglossidae (fig. 70), where the tongue is curled at the tip and supplied with a stiff brush of vibrissae.

The correlation of such tongues with a nectar, pollen, insect, diet is easy to see. Of further interest is the fact that members of most of these families possess the ability to very greatly extend the tongue. The hyoid bones are prolonged over the occiput in the same manner as that adopted by the woodpeckers, and like the latter may even extend well down to the base of the bill.

8. Rudimentary. Finally a natural group is formed of tongues that have lost the greater part or all of their function, a condition found among many families. Thus birds that bolt their food whole have this organ often merely a little fleshy cylinder a few millimeters long and no wider. This structure prevails in many of the fish eaters, as the booby, pelican, stork, gannet, darter (fig. 20), man-of-war bird, cormorant, and the like. Again in the huge-billed hornbills we find only a small and unimportant tongue; neither is this organ very large or of much apparent use in their allies, the kingfishers, or again in many of the Caprimulgidae, in which family it is often to be found small and rather simple in structure.

It is apparent in such a review that in a large number of forms tongue structures can be correlated with some special diet and the method of its procurement as might well be expected of an organ so intimately concerned with the function of obtaining food. The exceptions, however, are numerous and present most interesting problems. For example, no special adaptation is to be noted in the tongues of gulls, rails, sandpipers, and the like unless, as it seems not at all improbable, special tactile or even taste sense is located in them. Added to these are certain odd and rather complex tongues the unusual shapes of which are difficult to explain. An instance is this organ in the fruit-eating trogons (fig. 21). It is triangular, thick, heavy, horny tipped, with a central groove bordered by distinct ridges and heavily armed posteriorly with spines. The motmots have a long slender structure, thin and horny and much frayed laterally, somewhat resembling that found in toucans (fig. 87), in which birds, again, a most curious featherlike organ is found with the frayed lateral margins directed anteriorly, the significance of which can not be evaluated at present.

In addition a most difficult problem is the explanation of variations in closely related birds where presumably the diet is very similar. Thus Lucas[8] called attention to the variation found in the genus *Melospiza*. In *M. fasciata* a much-frayed tip is found, while in *M. lincolni* the tip is only slightly bifid and not frayed. To this may be added the genus *Zosterops*, with a forked and smooth tongue in *Z. lateralis*, while it is much curled and frayed in *Z. simplex* and *Z. japonica*. Still again among the warblers of the genus *Dendroica* it varies from a flat and only slightly split organ in *D. petechia* (fig. 155) and *D. fusca* (fig. 158) to a much curled split and frayed one in *D. tigrina* (fig. 2).

The taxonomic value of the tongue in birds is an interesting question which can only be answered by a systematic survey. It is evident that the most useful characters for classification are those founded on strict morphological bases and any structure highly modified in response to external stimuli is of the least value. But no one organ has ever been found that can serve as a complete basis for classification. The history of ornithology evidences many mistakes due to the use of one character alone, as witness the old group Pinnatipedes, including phalaropes, coots, and grebes, through similarity of foot structure. In considering the value of the tongue it must be recognized that it is a highly adapted organ, but this should not rule it out from all taxonomic consideration. If every structure adaptively modified be omitted no part of a bird can be used, since to a greater or less extent this includes the whole organism. Lucas,[8] taking note of the adaptive modifications, gives it very little taxonomic value. There is, however, need of a systematic study of this organ in every group, with an evaluation of it in each one. While tongues are adaptively modified it may well be that these changes are constructed on a type pattern distinctive of the group to which the bird belongs and thus indications of affinity be given.

## Order COLYMBIFORMES

Loons are distinguished from grebes by the fact that the tongues of the former have a large patch of spinose processes at the base, while the grebes have but a single row posteriorly. *Gavia immer* (fig. 23) has a relatively large patch, while this is not so prominent in the Pacific loon, *Gavia pacifica* (fig. 22). *Podilymbus podiceps* and *Æchmophorus occidentalis* among the grebes have but a weak row of spines, which in the eared grebe *Colymbus nigricollis californicus* (fig. 24) are prominent but broad and flat.

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[8] Lucas, F. A. The Taxonomic Value of the Tongue in Birds. The Auk, vol. 13, No. 2, April, 1896, pp. 109-115.

## Order SPHENISCIFORMES

The penguins so far as known have a characteristic tongue. It is rather long and pointed and the surface is entirely covered with large stiff conical retroverted spines.

## Order PROCELLARIIFORMES

In this group there is considerable variation. On the whole it tends to be rather small in comparison to the bill and gape. In *Bulweria bulweri* it is very small, approaching rudimentary, while in *Macronectes* and *Prion* it is larger and more nearly matches the bill in size. In some genera it is well armed with spines, not only posteriorly but along the sides almost to the tip. Thus *Fulmarus glacialis glupischa* (fig. 25), *Pterodroma hypoleuca*, and *Puffinus cuneatus* have lateral spines for the posterior third, while *Bulweria bulweri* extends this to one-half and *Puffinus griseus* (fig. 8) and *Priofinus cinereus* are supplied the whole length of the tongue. This characteristic does not hold good for the entire family Procellariidae, however, since lateral spines are lacking in *Halobaena coerulea* and *Prion desolatus*. In the former one finds a rather small, cylindrical, fleshy tongue armed with a single row of very weak spines and tapering to an unsplit tip. The latter has lost most of the posterior row, so that this edge is often a smooth, rounded margin. Occasionally one finds a few inconspicuous spines buried in tissue, the value of which must be negligible.

The Hydrobatidae have very small tongues. *Oceanites oceanicus* and *O. gracilis* possess small fleshy cylinders with a weak row of spines.

## Order CICONIIFORMES

This is a rather unwieldy group with tongues that vary from minute rudimentary structures to the large fleshy one of the flamingoes.

The Steganopodes are characterized without exception, so far as is known, by rudimentary tongues. In *Phalacrocorax*, *Sula*, *Pelecanus*, and *Anhinga* it is a mere toothpick of flesh. *Anhinga anhinga* (fig. 20) has a curious little tonguelike eminence on the dorsum of the cylindrical rudiment. *Phalacrocorax* has a tongue composed of two plates of cornified tissue meeting in the midline and sloping sharply like a steep roof. *Fregata minor* presents a small triangular structure which has not as yet lost all form and on the surface of which posteriorly are to be found abortive spines.

The Ardeidae have a most characteristic organ already described, the most outstanding feature of which is the soft fleshy posterior flap connected with flexible lateral "horns." So far as has been determined this is a form not approached by any other family of birds and once having been seen is so characteristic that it could not be confused with any other form, most especially with the storks with which herons have often been classed and with which they agree in feeding habits. It is long in *Ardea herodias* (fig. 32) and shorter in *Nycticorax nycticorax naevius* (fig. 31) but with the same general structure throughout, including *Egretta candidissima*, *Casmerodius egretta*, *Botaurus lentiginosus* (fig. 33), and *Butorides virescens anthonyi* (fig. 34).

Of great interest is the fact that in that odd-billed form the boat-billed night heron (*Cochlearius zeledoni*) the same structure is preserved. The tongue is very short but is constructed exactly as in the other herons, much as if the tongue of *Ardea* was cut to the length of an inch or less.

The storks (*Ciconiidae*) have rudimentary tongues, as do the Ibididae (Threskiornithidae). *Ciconia ciconia* (fig. 26) has a flat almost formless structure, while *Plegadis guarauna* has one that is very small but with some semblance of structure, as there are well-defined spines present which, however, are flexible and functionless.

The flamingoes (Phoenicopteridae) are characterized by fleshy tongues supplied on the dorsum with conical spines and posteriorly with a patch of spinose processes. These curl downward, as do the bills. Figure 11 illustrates the tongue of *Phoenicopterus ruber.*

It is interesting to note that the four suborders are readily separated by tongue form. The Steganopodes by rudimentary cylindrical ones (except *Fregata*), Ardeae by their characteristic ones, Ciconiae by flat rudimentary, and Phoenicopteri by large fleshy tongues.

## Order ANSERIFORMES

The screamer (*Chauna chavaria*) of the Palamedeidae has a flat tongue with a single row of spines posteriorly not at all like the Anatidae, but resembling more that organ in the gallinaceous birds.

The Anatidae have a characteristic organ which, while modified in response to diet, is readily recognizable as distinct from all others.

Most mergansers have a long slender structure with but one row of lateral hairs, while *Mergus serrator* (fig. 10) has a double row along the entire dorsal surface.

In *Branta canadensis* and *B. nigricans*, for tearing purposes, all of the hairs of the two lateral rows have been converted into strong backwardly directed spines, one row on each side, while the dorsal surface is smooth, without the usual gutter. Such an organ is incapable of much if any sifting.

*Chloëphaga leucoptera* has a very curious flat tongue. Anteriorly there is a single row of very weak lateral spines or hairs which a little further back develops into three heavy conical tearing "teeth." Posteriorly it ends in a patch of small spines. This is, so far as has been seen, the simplest form found in the family.

The swans have the typical structure found in the family, which is modified, however, by having heavy tearing "teeth" along the edges of the median groove. This is true of *Cygnus gibbus*, *C. buccinator*, and *C. columbianus.*

*Coscoroba coscoroba* has a very heavy organ, but the edges of the median groove are smooth without corrified processes.

*Cereopsis novaehollandiae* has a most aberrant form of tongue. Typically there is a very weak row of lateral spines, which may be entirely worn away as in the specimen illustrated (fig. 35). Posteriorly there are various fleshy processes which may be covered with weak spines, absent in the one figured however.

The number of lateral "teeth" vary throughout the family and roughly follows subfamily groups.

Thus the Fuligulinae tend to have from three to five, usually four on each side. While members of the same species may not show a constant number the variation will be found to be within these limits. This is true of *Oidemia*, *Charitonetta*, *Histrionicus*, *Arctonetta*, *Marila*, and *Erismatura jamaicensis* (fig. 29).

On the other hand the Anatinae present from 5 to as high as 12 lateral spines. This is true of *Dendrocygna*, *Anas*, *Dafila*, *Poecilonetta*, *Mareca*, *Nettion*, and *Querquedula cyanoptera* (fig. 9). *Spatula*, being a broad and long tongued form, has as many as 12 on each side.

*Aix*, *Plectropterus*, *Cairina*, and *Dendronessa* average four to the side, while typically this group is marked by an absence of cornification of the edges of the median groove.

Throughout this group there is a similarity of tongue form that makes each one recognizable as belonging to the family Anatidae. The modifications that exist are all based on a type pattern which is characterized briefly as a fleshy organ with at least one, and usually two, rows of lateral hairlike processes, a few or all of which may be agglutinated to form solid cornified toothlike projections. In these instances it is notable that dissimilarity of diet has not destroyed evidences of relationship. Conversely, similarity of diet as compared with unrelated forms outside the family has not produced similar tongues. As instance witness on the one hand the tongues of several fish eaters—mergansers, loons, and grebes—and on the other the ruddy duck with its diet closely following that of the American coot, and yet without paralleling it in tongue pattern.

Within the family there is no reliable basis for separation on tongue form alone. The mergansers are recognizable as a separate group, as are the heavy tearing tongues of the geese and swans, and roughly the Fuligulinae may be distinguished from the Anatinae by the number of lateral "teeth." But with the exception of certain very odd types that mark special genera, as *Chloëphaga* and *Cereopsis*, or a characteristic wide tongue as in *Spatula*, there is often doubt as to what genus and subfamily a single specimen should be referred.

## Order FALCONIFORMES

In this group the tongue is a heavy rasping organ. The Cathartidae and the Vulturidae have a deeply curled organ, trough-shaped, with the upcurled margins armed with strong rasping spines. These range in size from the relatively small one of the buzzard, *Cathartes aura septentrionalis* (fig. 38), to the large powerful object of the condor, *Sarcoramphus gryphus* and *Gyps fulvus*, with extreme uniformity of pattern.

In the hawks the posterior border of the tongue may consist of one row of spines or of many, and on this character they may be divided into two natural groups; that is, the Buteonidae, with a single row, and Falconidae, with many spines distributed over the basal portion, as was first suggested by Beddard.[9]

Among the Buteonidae the following genera have been found to present but a single row of spines posteriorly:

*Milvus.*
*Circus* (*hudsonius*, fig. 40).
*Leucopternis.*
*Spizaëtus.*
*Archibuteo.*
*Dryotriorchis.*
*Morphnus.*
*Asturina.*
*Urubitinga.*
*Gypohierax.*
*Accipiter* (*cooperi*, fig. 43).
*Astur.*
*Elanus.*
*Urospiza fasciata.*
*Ictinia.*
*Rupornis.*
*Buteo.*
    *B. lineatus elegans* (fig. 12).
    *B. borealis calurus* (fig. 37).
    *B. albicaudatus* (fig. 42).

*Pandion haliaëtus* has a single row, but occupies a family of itself.

The following Falconidae have been found to have many spines distributed over the posterior portion of the tongue:

*Tinnunculus alaudarius.*
*Milvago chimango.*
*Hieracidea berigora.*
*Polyborus* (*plancus*, fig. 41).
*Falco.*
    *F. sparverius phalaena* (fig. 39).

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[9] Beddard, F. E. On the Modifications of Structure in the Syrinx of the Accipitres, with Remarks Upon Other Points in the Anatomy of That Group. Proc. Zool. Soc. London, 1903, vol. 2, pp. 157–163.

The tongue of the lämmergeier *Gypaëtus barbatus* (fig. 36) is very much curled in the anterior third and converted into a scoop or trough-like structure.

In searching for evidences of affinity one is struck by the close similarity of the heavy, rasping, mucous gland bearing, spinose tongues of the owls, which with their multiple rows of spines, resemble the Falconidae. A connecting link to the Buteonidae indeed would seem to be shown through the hawk owl (*Surnia ulula*, fig. 44). Since other evidence does not support this appearance of relationship it is apparent that convergent evolution and similarity of diet have so altered this organ in these divergent types that little dependence may be placed on it outside of limited groups.

The Galliformes, so far as has been determined, all have fleshy tongues, varying with the length of the bill, usually somewhat grooved and provided with a single row of rather prominent posterior spines.

The hoatzin *Opisthocomus cristatus* (fig. 45) has a triangular-shaped flat tongue the surface of which is set with small spinules.

## Order GRUIFORMES

The Rallidae have simple fleshy tongues varying in length with the length of the bill. They are 'upcurled along the edges to form long, slender, guttered or grooved organs that are usually frayed at the tip and provided posteriorly with short and rather inconspicuous spines. They are long and slender in *Pardirallus r. rytirhynchos*, *Rallus levipes* (fig. 47), *Neocrex erythrops*, and *Hypotaenidia wakensis*, while in the coots (*Fulica americana*, fig. 53) and gallinules (*Gallinula galeata*, fig. 30, and *Ionornis martinica*, fig. 59) they are shorter and broad, and the same holds true for *Porzana carolina*. The Weka rail *Ocydromus earli* has a rather large and heavy one which anteriorly is trough shaped, the edges and tip of which are split to form stiff forwardly directed fimbriations.

Aramidae: *Aramus vociferus* (fig. 49) has a long slender tongue considerably split at the tip.

Psophiidae: *Psophia leucoptera* has rather prominent posterior spines. The tip is characteristically frayed and the general appearance not at all unlike that seen in rails.

Otididae: *Otis tarda* has a flat tongue that is heavily armed with powerful spines along the posterior edge and the lateral borders for two-thirds of the distance between base and tip. This is rather suggestive of the tearing organ seen in the geese.

Rhinochetidae: *Rhinochetus jubatus* has a long, slender tongue with weak posterior spines, very slightly grooved and ending in a cornified tip that is somewhat frayed.

Eurypygidae: *Eurypyga helias* (fig. 52).

# Order CHARADRIIFORMES

The tongues of the Limicolae very much resemble those of the rails. They usually are commensurate in length with the bill, although in *Numenius*, *Recurvirostra americana* (fig. 50), and *Mesoscolopax borealis* they lie only in the floor of the mouth and do not extend far toward the tip of the bill. The last-named species has an exceedingly narrow tapering organ that in the anterior portion becomes almost threadlike and does not measure more than one-third the length of the bill. In the rails the tip was found often to be split and frayed while the sandpipers generally have a tip entire. Usually the tongue is guttered or grooved but in the genera mentioned above it tends to be flat. It may be very long as in *Catoptrophorus semipalmatus inornatus*, and the long-billed dowitcher (*Limnodromus griseus scolopaceus*, fig. 48) and less so the wandering tattler, (*Heteroscelus incanus*, fig. 46), while it is very short in the semipalmated plover (*Charadrius semipalmatus*, fig. 60).

Other variations are seen in *Actitis macularia* (fig. 54), *Oxyechus vociferus* (fig. 58), *Haematopus palliatus* (fig. 61), and *Ereunetes pusillus* (fig. 57). There is nothing unusual about this organ in *Oreophilus ruficollis ruficollis*, *Pisobia minutilla*, *Crocethia leucoptera*, or *Squatarola squatarola*. In this group, as in the hawks and owls, due to convergent evolution or to the fact that feeding habits are alike there has developed a very close resemblence to the tongues of rails and an indication of affinity when in fact it is not as real as this organ would lead to believe. So close is the appearance between the groups that given a single tongue one would often be in doubt as to its true connection.

The gulls have a rather broad fleshy tongue that is somewhat grooved and is often forked at the tip, as illustrated by *Larus heermanni* (fig. 27) and *L. occidentalis* (fig. 28). The terns have long, slender, often forked tongues (*Sterna forsteri*, fig. 56) and *S. antillarum*, fig. 55). *Gygis alba kittlitzi* has remarkable fine backwardly directed serrations for the anterior one-half of this organ.

*Rynchops nigra* (fig 51) has a rather short, wide tongue, somewhat scoop shaped.

Pigeons have flexible tongues that are grooved and posteriorly are supplied with soft spines that are without resistance. These are illustrated in the following figures, *Zenaida vinaceorufa* (fig. 65), *Columba gymnophthalma* (fig. 66), *Histriophaps histrionica* (fig. 63), and *Geopelia cuneata* (fig. 64), while *Nesopelia galapagoensis* is very similar.

## Order CUCULIFORMES

In the cuckoos the tongue is rather heavy, long, and well provided with spines. There may be considerable variation in length in the same species, as illustrated by that odd form *Geococcyx californianus* (figs. 67, 68), while the color may be entirely black with white spines or flesh colored with a few black spots. *Saurothera dominicensis* (fig. 69) has much fimbriated edges which are directed forward. *Coccyzus melacoryphus* has a very similar structure. *Carpococcyx radiatus* is well armed posteriorly, but the edges are not split nor is the tip.

## Order PSITTACIFORMES

The parrots are characterized by considerable differences in tongue shape. In the common grass parakeet (*Melopsittacus undulatus*, fig. 72) it is flat and broad, while it is broad but hollowed out in *Aprosmictus cyanopygius* (fig. 71), *Conurus auricapillus* (fig. 17), and *Poiocephalus senegalensis*. It is tightly rolled in *Calopsitta novaehollandiae* (fig 73), while, as is well known, it is brush tipped in the Trichoglossidae, as illustrated by *Psitteuteles chlorolepidota* (fig. 70), *Glossopsitta*, *Hypocharmosyna*, and *Trichoglossus*, and in which group the tongue is used as the main taxonomic feature.

## Order CORACIIFORMES

*Coracias caudata* has a lingual structure very similar to that of a robin, with a horny split tip. It is not commensurate in size with the heavy bill, while posteriorly there are very few spines.

*Eurystomus*. In this large heavy-billed form the tongue is wide and flat, the anterior one-half is horny and frayed, while at the back there are three to four large heavy spines on each side.

The motmots have flat, heavy tongues that are considerably frayed laterally with laciniae that are directed forward. In *Eumomotus superciliaris* this is carried to such a degree that it strongly suggests the feathered structure seen in the toucans. *Momotus caeruleiceps* is not unlike the tongue of *Saurothera* in its general appearance.

The todies have the anterior half thin, horny, and translucent, but the edges are merely roughened and irregular and not deeply incised. *Todus multicolor* (fig. 74) is illustrative.

In kingfishers (Alcedinidae) this organ has become rudimentary. In *Ceryle alcyon* (fig. 75) it is flat without the posterior row of spines although *Ceryle rudis* may show a few. The large billed *Pelargopsis* (*Ramphalcyon*) has a structure very similar to *Ceryle* with the exception that the tip is either square or even somewhat indented while the whole organ is quite rudimentary. There is no suggestion of affinity between these forms and the motmots.

The hornbills (Bucerotidae) also have rudimentary tongues, although they are not without form. Thus in *Lophoceros melanoleucus* (fig. 84) it is flat, slender, and square tipped, while in the huge billed *Hydrocorax mindanensis* it is rather triangular, fleshy and supplied with a few small spines, and this is true also for *Dichoceros bicornis*.

Upupidae: The hoopoes have exceptionally small rudimentary tongues which are reduced to a mere triangle of flesh without form or function.

Such a review shows that a wide range of variation is seen in the suborder Coraciae, with few indications of affinity shown and in many forms a rudimentary structure through loss of function.

The suborder Striges have tongues very closely resembling those of hawks, a suggestion of affinity that is misleading.

They are horny tipped and well beset with papillae, while mucous gland pores are abundant, an appearance much like that of the Falconidae and due either to convergent evolution or to the raptorial diet. There is usually a certain degree of curling and the tip is often somewhat incised. As examples are shown *Tyto pratincola* (fig. 78), *Speotyto cunicularia hypugaea* (fig. 76), *Otus asio bendirei* (fig. 79), *Spiloglaux novae zealandiae* (fig. 80), and *Asio wilsonianus* (fig. 77). The hawk owl (*Surnia ulula*, fig. 44) has but one row of spines posteriorly, the reason for which is not apparent. The horned owl (*Bubo virginianus*) has a broad, flat tongue well covered with spines.

## Suborder CAPRIMULGI

In this group, Wetmore[10] finds four main types of tongues. First that of *Nyctibius*, which he describes as "small in proportion to the mouth cavity as in other Caprimulgi. In form it differs considerably from the tongues of related genera. The tip of the tongue in *Nyctibius* is somewhat elongate, with the lateral outlines at first concave. The postero-lateral margins are produced as elongate points that equal the anterior portion in length. The outline of the lateral margin of these is convex. In general the form of the tongue is that of the head of a spear point, with a deeply incised base, spreading posterior angles, and slender point." He finds the lateral margin supplied with spines and a few minute spines on the upper surface.

*Podargus* is described as having an elongate tongue, being "much larger in proportion to the size of the mouth cavity than in other forms examined. The anterior end of the hyoidean apparatus forms a thickened, pointed projection in the tongue base. * * * Anterior to this strong base the tongue is thin and translucent, being not much thicker than a sheet of ordinary writing paper."

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[10] Wetmore, A. On the Anatomy of Nyctibius, with Notes on Allied Birds. Proc. U. S. Nat. Mus., vol. 54, pp. 577–586, 1918.

*Steatornis caripensis* shows a "tongue shaped like an arrowhead, with rather elongate, bluntly pointed tip, convex lateral outlines, and spreading, somewhat slender posterior processes that project beyond the hinder border. The margins of these posterior processes are armed with soft, slender, backward projecting papillae, and smaller papillae of the same nature are found on the upper surface of these projections."

The tongue of *Phalaenoptilus nitidus* "is small, measuring 9.5 mm. long by 3 mm. broad. The postero-lateral spinose processes are elongate and pointed. The lateral margins in outline are approximately straight lines. Spinose backward projecting papillae begin at a point anterior to the center and become stronger and heavier toward the base of the tongue. The upper surface of the tongue for its basal two-thirds is thickly set with small horny papillosities all projecting backward. Because of the posterior elongation of the lateral processes, the basal margin appears deeply incised."

This is the general form of the remaining genera of the Caprimulgidae. The tongue of *Chordeiles virginianus* is described as showing a "slightly different development. This organ in the nighthawk is small in comparison to the size of the mouth opening, but is strong and heavy. It measures approximately 9 mm. long by 4.7 mm. broad at the base, so that it is short and broad in comparison with the lingual appendages of other genera in this family that have been described. * * * In outline the tongue of *Chordeiles virginianus* is triangular with the lateral margins slightly concave. * * * The lateral margins of the tongue are armed with spinose papillae which are small and weak anteriorly and become strong and heavy toward the base. Stronger processes arm the posterior margin, and the broadened basal third of the tongue has its dorsal surface covered with pointed harsh papillosities all directed toward the pharynx." With this description the tongue of *Chordeiles acutipennis texensis* (fig. 81) agrees, with the exception that there are no papillosities on the dorsal surface.

The tongues of *Nyctidromus albicollis*, *Caprimulgus europaeus*, and *Setochalcis vocifera* are described by Wetmore as resembling in form that of *Phalaenoptilus nitidus*, while that of *Chordeiles acutipennis* is like that of *C. virginianus.*

It can thus be seen that there are considerable differences manifested in this group not easy of explanation and which do not give any important information as to affinities.

The Cypselidae do not show any striking tongue characters. In some forms there is a close resemblance to tongues of swallows, as

Lucas[11] pointed out in the case of *Collocalia* (fig. 85, after Lucas) while others have a longer, more slender tongue somewhat curled as in the tree swift *Macropteryx coronata* (fig. 82).

The humming birds (Trochilidae), however, have most characteristic tongues, which are distinct from any others in the class of Birds. The cartilaginous portions of the ceratohyals are divided in the anterior half of the tongue to form separate shafts. These are invested with a membranous covering which is expanded as a lateral flange at the tip, but which inrolls as the base of the tongue is approached to form a rolled membranous tube on each side. (See fig. 86, *Calypte anna.*)

It is not composed of parallel muscular tubes, as has often been described, for the cartilaginous shafts of the tongue are solid; but it is the inrolled fringe of membrane along the lateral margins of these shafts that make up the capillary tubes. This is an entirely different condition than prevails in the passerine flower frequenters where two or more muscular tubes are formed by splitting and curling of the body of the tongue itself.

It is very elastic in the humming birds and capable of great protrusion, the hyoid apparatus also being especially long to permit of this action.

This is a most characteristic organ which readily identifies any bird possessing it as a member of this family, and while markedly modified in response to flower-feeding habits is nevertheless distinctive of the group and hence of taxonomic value.

The trogons have flat, heavy tongues supplied with numerous spines and with a cornified tip. There is a central groove bordered by raised margins, a condition most unusual and not seen elsewhere, except in members of the next group. (*Pyrotrogon neglectus*, fig. 21.)

The puff-birds (Bucconidae) have odd flat tongues that about the center widen to form prominent shoulders, gradually narrowing from this point anteriorly to a blunt tip. The surface is flat except in the anterior third, where a groove is seen, the margins of which are raised forming parallel prominent ridges on the surface. This is well illustrated by *Bucco bicinctus* (fig. 83) and is also seen in *Notharchus dysoni* and *Nystalus maculatus striatipectus.* These are very unusual appearing structures the exact functions of which are not known.

The Ramphastidae are characterized by exceptionally odd feathered tongues which are long and narrow and with deeply incised lateral margins forming anteriorly directed laminae. The fleshy hyoidean portion forms but a small part of the tongue posteriorly while anterior to this it becomes thin, horny, and translucent. This change is marked by the dotted line on figure 87, of the tongue of *Pteroglossus frantzii.* This is so striking and characteristic an appearance that it would seem useful for taxonomic purposes.

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[11] The Auk, vol. 13, pp. 109–115, April, 1896.

The Picidae possess a tongue so distinctive of the group, that while modified in response to diet, it could in no way be confused with that of any other family. Even the odd little piculet *Picumnus*, with its rounded tail so unlike that of woodpeckers, has a tongue which, except for its small size, is perfectly typical of the group as exemplified by *Dryobates.* This is the more interesting since the diet of so small a bird must much more nearly approximate that of the creepers, titmice, and nuthatches than of its larger allies and yet the tongue remains in all respects truly that of a woodpecker.

Typically the tongue is very extensile and the tip is armed with six or seven sharp backwardly directed barbs. This is found in *Dryobates villosus hyloscopus* (fig. 88), *Dryobates nuttalli* (fig. 89), *Picus*, *Gecinus*, *Xenopicus albolarvatus* (fig. 13), *Geocolaptes*, *Dendrocopus*, *Centurus*, *Chryserpes*, *Micropternus*, *Dyctiopicus*, and *Yungipicus. Picoides americanus dorsalis* has a rather small tongue for so large a bird, while the barbs at the tip are delicate. *Veniliornis cecilii* has a small tongue with but a few barbs and the same is true for *Nesoctites micromegas.* It is also surprising to note that the very large *Phloeotomus pileatus*, with its large, heavy bill, has an astonishingly small tongue in comparison with the rest of the body. The tip is very short and small and is armed with but four or five barbs.

*Colaptes cafer collaris* (fig. 14) has the most extensible tongue, but it is not so well accommodated for impaling objects as the tip is not as sharp, nor are the barbs prominent, being reduced to but two or three.

*Melanerpes* (*formicivorus bairdi*, fig. 15) has converted the barbs to hairlike processes and *Sphyrapicus* (*thyroideus*, fig. 16) has extended this process for the greater part of the length of the tongue, while the ability to project this organ is much reduced.

The wrynecks or Jyngidae are distinguished from the other members of the family by the fact that while the tongue is long, wormlike, and extensile, the sharp tip is not supplied with barbs. In this group they are lost, and the tip while sharp, is smooth.

It is interesting to note that in these birds as in the piculets the tail is soft without spiny shafts, which is misleading from a taxonomic standpoint, and that thus in both of these groups the tongue is a better guide to relationship.

Furthermore the Dendrocolaptinae possess stiff spiny tails which would mislead one in the conclusion that they are allied to woodpeckers when no relationship exists; whereas, in spite of the fact that feeding habits are similar to the latter, the tongues are wholly unlike and therefore yield more reliable evidence.

In this family the tongue fulfils all the requirements for taxonomic use in that differences in feeding habits in related forms have not altered the fundamental pattern in the group, so that the tongue alone is sufficient in all instances to refer its owner to the family and in many instances to the correct subfamily and even genus. Conversely, similar feeding habits in unrelated forms (Dendrocolaptinae) have not produced tongues like these, and this is the more striking since the tail, in response to such habits, has taken on the spiny character so common to that of woodpeckers.

## Order PASSERIFORMES

In this heterogeneous group where so much variability is found in all of the anatomy it is not surprising to find the tongue taking part in this diversity in form. A brief survey of this has already been given in an earlier part of this paper; it remains to classify and group such differences.

In many families the thin horny tongue, slightly curled and frayed at the tip, as described for the robin, is found with but slight differences in length and width. Such a tongue has no outstanding character sufficient to identify the particular family to which it belongs and serves to do no more than to indicate a member of the order. As example *Pitta erythrogaster* (fig. 90) is illustrative.

The flycatchers (Tyrannidae) have tongues which are often broadened at the middle, somewhat curled, incised at the tip and often slightly frayed. As examples, are *Myiochanes richardsoni* (fig. 91), *Pyrocephalus rubinus mexicanus* (fig. 92), *Sayornis sayus* (fig. 93), and *S. nigricans* (fig. 94), *Nuttallornis borealis* (fig. 95), *Empidonax griseus* (fig. 96), *Tyrannus verticalis* (fig. 97), and *Tolmarchus gabbi* (fig. 98). The tongue of *Culicivora stenura* is very similar to those forms as is that of *Muscisaxicola maculirostris*. See figure 99 which illustrates *Myiarchus dominicensis*.

There is nothing remarkable about the organ in *Pachyramphus viridis viridis*.

The South American bell bird, *Chasmorhinchus*, has a rather simple flat tongue that is slaty black, matching the gape in color. The postero-lateral branches are long armed with slender spines while the tip is slightly incised and the whole organ is comparatively small in relation to the size of the mouth.

The Dendrocolaptidae are interesting in that the feeding habits of many of them are similar to woodpeckers without developing tongues like the latter. In most of these the anterior two-thirds or more of the tongue is thin, horny, and translucent, and somewhat frayed, while the whole organ is of good length in proportion to the length of the bill. This is true of *Dendrocolaptes picumnus* and several species of *Picolaptes*. But one specimen of *Drymornis bridgesi* was available and in an excellent state of preservation. In this bird the tongue was exceptionally small, out of all proportion to the huge sickle bill and not at all like the above-mentioned genera. The appearance was much as if the horny anterior end of the tongue was either absent or had been shed. Whether this is an accidental or natural state is not known. Figure 100 illustrates the tongue of *Furnarius agnatus*, which is somewhat fleshier than ordinary and is not supplied with so great a proportion of horny tip. This is true also of *Cinclodes*. Figure 101 illustrates *Sittasomus*, species. (?)

The Formicariidae have thin horny tongues that are frayed somewhat more than the ordinary, extending well back along the sides, as exemplified by that of *Gymnocichla nudiceps* (fig. 102). *Thamnophilus bridgesi* (fig. 103) shows much the same structure.

Figure 104 illustrates the tongue of *Oligura superciliaris*, one of the Timaliidae.

Among the Pycnonotidae, *Pycnonotus* shows a simple flat tongue that is bifid but not frayed, while *Iole philippinensis* has one somewhat curled and both forked and frayed at the tip.

There is little to characterize the Muscicapidae, as the tongues seen are with minor variations much like the standard pattern.

The thrushes and their allies depart from the usual structure by the addition of papillosities on the dorsal surface of the tongue around the basal portion. This is exemplified by *Hylocichla guttata* (fig. 106), *Myadestes townsendi* (fig. 105), *Mimus polyglottos leucopterus* (fig. 107), and *Sialia mexicana* (fig. 108).

*Polioptila caerulea obscura* (fig. 116) does not have this arrangement, but is supplied with only a single posterior row while the tip is considerably frayed.

*Cinclus mexicanus* (fig. 110), of the family Cinclidae, has a simple rather fleshy tongue slightly curled and frayed.

The wrens, Troglodytidae, are marked by very thin, horny, translucent, long tongues through which the contained bones are plainly visible. The posterior spines are prominent and needlelike, while the main postero-lateral projections consist of prominent rounded horny spines; an apperance that is quite characteristic, and is not lacking even in that nonwrenlike form *Heleodytes brunneicapillus couesi*. Figures 112 and 111 represent this organ as seen in *Catherpes mexicanus punctulatus* and *Thryomanes bewicki charienturus*, respectively.

*Chamaea fasciata* has a trough-shaped square-tipped tongue well supplied with entangling hairlike processes very suggestive of that seen in the nuthatches. The tract between the base of the tongue and the glottis has many pores of mucous glands.

Swallows have a simple flat tongue somewhat split at the tip, as illustrated by *Petrochelidon lunifrons* (fig. 115), and very similar in appearance to Collocalia (fig. 85, after Lucas).

The "cuckoo-shrikes" (Campephagidae) have tongues of the standard pattern, with perhaps more fraying than usual. At least this is true of *Pericrocotus exsul* and *Malindangia macgregori. Lalage niger* shows very fine lateral fraying, while *Graucalus* has much the same appearence, the tongue, however, not matching in size the large bill.

In the drongos (Dicruridae) this fraying becomes in some forms very elaborate. Thus, in *Chibia hottentotta*, the tongue is deeply split and the sides are incised, forming long, delicate, forward-pointing hairlike fringes, the delicate strands of which are very uniform in size and length. This is only slightly less marked in *Dicrurus longicaudatus* while in *Bhringa remifer* the processes are very short and delicate. *Dissemurus paradiseus* is much the same, while *Bhuchanga longa* has considerably less fraying.

Some of the Bombycillidae have simple flat tongues (*Bombycilla*), in appearence much like those of swallows, while *Dulus dominicus* (fig. 117) has a much curled tip, which is frayed.

The shrikes are an ill-defined group, Laniidae. There is little characteristic about the tongue. That of *Strepera graculina* is illustrated in figure 133, while *Lanius ludovicianus gambelii* is illustrated in figure 114.

The vireos have simple flat tongues, as represented in figure 119. *Vireo*, species from Tortuga Island, *Lawrencia nana* (fig. 118), and by figure 120, *Vireo belli pusillus.*

The Sittidae as well as the Paridae have impaling organs through the ends of which the cartilaginous tips of the ceratohyals often project. This is illustrated in figure 121, *Sitta carolinesis aculeata*, and figure 122, *Sitta pygmaea.* The titmice and chickadees have four-pronged tongues. See figure 124, *Baeolophus inornatus*, and figure 123, *Penthestes gambeli baileyae.*

The verdin, *Auriparus flaviceps* (fig. 126), and the bush-tit, *Psaltriparus minimus californicus* (fig. 125), have very irregular lacerated tips, while *Certhia familiaris zelotes* (fig. 113) is not far removed.

The Corvidae have a tongue the anterior third of which is composed of thin, translucent, horny tissue which is often rather deeply incised and is whipped out. The main postero-lateral spines are bifid or double, while over the surface around this region there are many small papillosities. As examples are *Aphelocoma californica* (fig. 128), *Cyanocitta stelleri frontalis* (fig. 130), *Nucifraga colum-*

*biana* (fig. 132), and *Pica nuttalli* (fig. 129). The entire appearance is very characteristic.

The tongues of some of the Sturnidae are of the standard pattern as exemplified by *Scissirostrum dubium* (fig. 131), while *Lamprocorax chalybea* and *L. metallicus* are very similar.

The tongues of the next six families are some of the most elaborate and marvelous throughout the Class of Birds.

The Dicaeidae have small tongues that are flat posteriorly but at about the middle become abruptly narrower and begin to curl into a semitube which is deeply cleft at the tip, the margins of which are smooth, forming two slender semitubular tips. This is found in *Dicaeum cruentatum*, *D. sanguinolentum*, *D. flammeum*, and *D. celebicum*. In *Acmonorhynchus aureolimbatus* the same holds true except that the edges of each tube show a slight notching, with an attempt at the production of four tips, while in *Prionochilus* these notches have deepened to actual splitting with the formation of four semitubular fringeless projections.

The tongue of *Dicaeum trigonostigma* as figured by Gadow[12] shows a complete tubular arrangement by overlapping of the upcurled edges, which are not frayed. The tip is deeply bifurcated, forming two equal tubes, and the tip of each one of these again is cleft, forming a quadruple tongue.

The Zosteropidae.—As to this family some are simple in structure, being rather flat with only a slight tendency to curling, while the tip is deeply slit. Gadow[13] finds this true of *Z. simplex*. *Z. atrifrons* (fig. 135) shows some fraying of the margins, which is true also of *Z. sarasinorum*. This may be carried to the point where, with curling added to the process, elaborate curled split and fimbriated tongues are found as described of *Z. simplex* and *Z. japonica* by Beddard.[14]

The Nectariniidae.—In this family curling is the outstanding feature, so that the anterior one-half to two-thirds is a completely rolled tube the upcurled margins of which are overlapped and are not fringed or frayed. In some species there is some forking at the tip to form two tubular projections.

*Arachnechthra asiatica* has a very long tube for the anterior two-thirds, without splitting or fraying. *Arachnothera*, species (?) has a very long tube slightly frayed at the tip. *Cinnyris* (*Cyrtostomus*) *pectoralis* and *C. jugularis woodi* have slender tubes, both somewhat forked at the tip. *Hermotimia*, species (?) (fig. 141) shows the same arrangement.

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[12] Gadow, H. Structure of Certain Hawaiian Birds. The Birds of the Sandwich Islands, Wilson and Evans, London, 1890–99, pp. 219–241.

[13] Gadow, H. Proc. Zool. Soc., London, 1883, p. 63.

[14] Beddard, F. E. Ibis, ser. 6, No. 3, 1891, pp. 510–512.

*Cyanomitra verticalis* has a long slender tongue, longer than the bill, completely tubular, and somewhat forked, and this is true also for *Chalcomitra fuliginosa* and *Aethopyga boltoni.* In *Anthreptes fraseri*, *malaccensis*, and *wiglesworthi*, the bifurcation is more marked than in any of the others, so that practically a double tongue is formed.

On the other hand the tongue of *Chalcoparia phoenicotis* (fig. 139) is not at all like the above, and this fact together with other evidence has led Oates[15] to separate this species from the family. In view of the fact that there is such a regularity of tongue form in this family the divergence from it as seen in *Chalcoparia* may well have the significance that Oates gives it.

The Drepanididae typically have tubular tongues. These are formed as are all tubular ones by an upcurling of the margins of the horny anterior part which constitutes the major portion of the tongue in these birds. The edges of the dorsally rolled sides meet in the midline and finally overlap. As the tip is approached the edges become broken up and split, forming delicate laciniae. At first one side completely overlaps the other but as these fimbriations become more prominent they interlace in a complex manner finally forming at the tip a whipped-out brush.

This is the fully developed tongue and is well illustrated in the long-billed *Hemignathus procerus* (fig. 19). This same appearance is seen also in *Vestiaria coccinea*, *Chlorodrepanis*, and *Himatione sanguinea*, all of these, however, being shorter than the above. In *Heterorhynchus wilsoni* it is completely tubular only in the anterior third and is bifurcated.

*Loxioides bailleui*, which Doctor Gadow[16] first classed among the Fringillidae, is described by him as follows. The tongue is

> Thick and fleshy, much shorter than the bill, very slightly protractile, tip rounded off and ending in a neat horny scoop, which is formed by the lower horny covering of the tongue projecting a little; the brim of this scoop is slightly frayed out, as is the case in many Fringillidae.

*Oreomyza* (*Oreomystis*) *bairdi* he describes as:

> A little shorter than the bill, thin and horny but at first sight apparently different from that of the Drepanididae. However, the lateral horny margins are raised up dorsally and frayed out. The distal fourth of the tongue is slightly split into a right and left half but far less than in *Coereba.* This broader, shorter, and decidedly less tubular tongue is in conformity with the slightly broader bill.

*Loxops coccinea* he describes as "short, in conformity with the bill, but ending in a frayed-out single brush, which, like the whole organ, is formed exactly like that of the other Drepanididae." The tongue of *Hemignathus olivaceus* is "short and less tubular, being intermediate in structure and appearance between those of *Himatione* and *Vestiaria.*

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[15] Fauna of British India. E. W. Oates, Birds, vol. 2, p. 372.

[16] Gadow, H. Structures of Certain Hawaiian Birds. The Birds of the Sandwich Islands, Wilson and Evans, London, 1890–99, pp. 219–241.

*Psittirostra psittacea* (fig. 140) has a flat, fleshy tongue in which the long, horny curled portion is absent. The tip is blunt and not frayed. The appearance is almost exactly as if the tubular portion of the tongue of *Hemignathus procerus* had been cut away leaving the basal uncurled portion.

An entirely different arrangement is seen in the finchlike *Telespyza cantans*, however (fig. 136). Here the entire tongue is thick and fleshy, much as in some of the finches (compare *Passerculus rostratus*, fig. 137), with an uprolling of the thick margins to form a fleshy rolled tubular tongue not at all the same in appearance or arrangement as the tubular tongues of the foregoing forms, made up, as they are, by a prolongation and curling of the natural thin horny tip of the standard tongue.

It is apparent, therefore, that in this family there is a wide range in tongue forms, from which no reliable evidence as to relationship is to be drawn, as is evidenced by the error made by Doctor Gadow in the case of *Loxioides.*

The Coerebidae have tongues that are curled, split, and frayed, but not all to the same degree, and a fine series of modifications can be traced through this family. Thus in *Glossoptila* (*Euneornis*) *campestris* the tongue is practically flat in the posterior two-thirds. The anterior third shows a moderate upcurling of the lateral margins, with delicate fraying into a fringe that rolls inward but does not meet the opposite side. The tip is bifid, thus converting this portion into two very imperfect semitubular fringed projections. *Cyanerpes cyanea* (fig. 138) has the anterior one-half curled in much the same manner, while the tip may or may not be bifurcated.

*Cyanerpes lucidus* shows very little fraying of the margins of the tube, while *C. caeruleus* is deeply cleft and frayed. In *Chlorophanes spiza* (fig. 4) the tube is becoming more perfect by a close approximation of the upcurled edges. Finally in *Coereba bananivora* (fig. 5) the edges completely overlap, forming a true tube which by splitting becomes double tubes, the curling margins of which are much frayed. This same appearance is seen in *Coereba portoricensis* and *Diglossa plumbea*, the latter of which shows a surprisingly long tongue in comparison to the short bill.

The Meliphagidae have elongate quadruple tongues. The curled tongue first splits into a right and left half with marked fraying of the edges, forming two fringed tubes, and these are again deeply split and frayed, so that four elaborately frayed brushy tips are formed. The whole organ is as long or longer than the bill.

The appearance is illustrated by *Myzomela rubratra* (fig. 6), and the same appearance is seen in *M. nigriventris* and *M. sanguinolenta.* Whether the bird and tongue be a large one, as *Tropidorhynchus* and *Microphilemon,* or of moderate size, as *Meliphaga* (*Ptilotis*) *carunculata,* there is a surprising conformity to the pattern described. This same long quadruple tongue is present also in *Meliornis australasiana, Acanthorhynchus tenuirostris, Myzantha garrula,* and *Acrulocercus braccatus.*

So far as is known this extraordinary quadruple brushy tongue is limited to and characteristic of this family. It is an interesting fact that the formation of the multiple tubular and brushed tongues of these several families of flower-frequenting birds follows different lines of development using one or more of the fundamental tendencies of the type tongue to curl, split, and fray. Thus, as has been demonstrated, the Nectariniidae have almost purely *tubular* tongues, the Drepanididae *tubular* tongues with *frayed margins,* the Coerebidae combine *curling, splitting,* and *fraying,* to form double tubes, while the Meliphagidae carry this to the degree that *four curled brushy tips* are formed.

Among the Mniotiltidae there is a rather wide range of variation. As is the case with the type pattern these are tipped with horny thin translucent tissue which may form nearly one-half of the organ (see fig. 142, *Dendroica dominica*) or may be absent, which was the case in a second specimen of the same species and is also illustrated by *Vermivora celata lutescens* (fig. 143) and *Dendroica petechia gundlachi* (fig. 144). The tongue may be a thin, flat structure as in *Catharopeza bishopi* (fig. 145), *Dendroica occidentalis* (fig. 146), and *Dendroica palmarum* (fig. 147), or curled at the tip as in *Granatellus francescae* (fig. 148), by upcurling of the fraying margins a process which is carried to its greatest extreme in this family by *Dendroica tigrina* (fig. 2). There may be rather marked differences in shape as is evidenced by a tongue of *Wilsonia canadensis* (fig. 149), which is very broad at the middle, while others from the same species showed this to a lesser degree or not at all. *Certhidea salvini* (fig. 150) has a rather thick fleshy tongue, grooved shallowly and rather suggestive of the fringilline type.

There is thus in this group considerable variation even in such a small series as in the one genus Dendroica, as may be observed by the following figures: *D. nigrescens* (fig. 151), *D. auduboni* (fig. 152), *D. vigorsii* (fig. 153), *D. discolor* (fig. 154), *D. petechia* (fig. 155), *D. striata* (fig. 156), *D. castanea* (fig. 157), *D. fusca* (fig. 158), and *D. virens* (fig. 159). Other members of this family are *Teretistris fernandinae* (fig. 160), *T. fornsi* (fig. 161), *Wilsonia citrina* (fig. 162), *Wilsonia pileolata pileolata* (fig. 163), *Vermivora luciae* (fig. 164), *Compsothlypis americana* (fig. 165), *Oporornis tolmiei* (fig.

166), *Helmitherus vermivorus* (fig. 169), *Icteria virens* (fig. 168), and *Oreothlypis gutturalis* (fig. 167).

Family Tanagridae.—In some of this group the tongue is flat and thin, as in *Tachyphonus* (fig. 170) and in *Tanagra (Euphonia) violacea* (fig. 171). In others it is fleshy, as in *Thraupis darwini* (fig. 172), *Stephanophorus leucocephalus* (fig. 173), and *Ramphocelus brasilius* (fig. 174), while in the very large billed *Pitylus grossus* (fig. 175) the tongue is cylindrical and fleshy while the anterior half is hollowed out and scoop-shaped, very suggestive of some of the finches. *Phaenicophilus poliocephalus* has a longer tongue (fig. 177), which is considerably frayed at the tip.

The Ploceidae have a structure very similar to the finches, with a cylindrical fleshy tongue having a depression anteriorly to form a scoop. This is illustrated by *Munia punctulata* (fig. 178). The horny under surface is often folded over the dorsum to form a grooved tongue as in some of the finches and as is illustrated by *Steganura paradisea* (fig. 179). This is seen also in *Ploceus megarhynchus*, *P. bengalensis*, and a species of *Foudia* from St. Helena Island.

The Icteridae, as typified by *Icterus cucullatus nelsoni* (fig. 180), and *Icterus icterus* (fig. 3), have upcurled frayed margins to the tongue which may be deeply split to form double frayed semitubular tips. This is found also in *I. parisorum*, *I. wagleri*, *I. bullocki*, *I. mesomelas*, and *I. northropi*, all of which have tongues very suggestive of the Coerebidae with less advanced degrees of curling.

The blackbirds, as exemplified by *Molothrus atronitens* (fig. 181), have upcurled margins without fraying, forming a guttered organ with the tip somewhat whipped out. This is seen in *Agelaius phoeniceus*, *A. tricolor*, *Molothrus ater*, and *Dolichonyx oryzivorus*. *Gymnostinops montezumae* has little curling; the tip is bifurcated and frayed, while *Megaquiscalus major macrourus* has a bifid curled and much frayed organ, much like *Icterus*. *Pseudoleistes* (fig. 182) has a thin tongue somewhat curled and whipped out at the tip.

The Fringillidae have cylindrical fleshy tongues, which show much variation. Ordinarily the horny under surface projects beyond the tip, and this is often frayed and somewhat curled so that a small scoop-shaped end is formed. This same horny under surface invests the lateral margins of the tongue and often curls over the dorsal surface as indicated in *Loxia leucoptera* (fig. 185). The tongue may have long posterior branches as in the odd form assumed by *Passer domesticus* (fig. 183), or, as is usually the case, they are closely compressed to the basihyal portion. It may have simply a flat surface, as indicated in *Oberholseria chlorura* (fig. 186), or there may be a deep groove formed as in *Zamelodia melanocephala* (fig. 191). In the genus *Passerculus* the grooving is very marked so that in some of the species a rolled or tubular tongue is formed (see fig. 137 *Passerculus rostratus*).

In conclusion it is obvious that the tongues of birds subserve many different uses, a wide range of function that is paralleled by changes in form, ranging from simple rudimentary nodules of flesh to the highly complex multiple tongues of the flower-frequenting birds. Furthermore, when classified as to adaptations, eight natural groups are formed, to which many of these differing patterns may be assigned.

The type pattern of tongue is composed of a fleshy basal part which is tipped with a more or less extensive thin horny translucent anterior portion, which has an inherent tendency to curl, bifurcate, and fray laterally. One or all of these tendencies are utilized to produce many adaptive modifications, a fine series of which may be traced through the flower-frequenting birds, where they undergo the greatest development, producing elaborate and complex tubular, brushy, and multiple tongues.

Fundamentally the tongue is a paired structure arising, as it does, from the second and third visceral arches, and upon this foundation must be constructed all the variations seen. Practically, however, in the fully developed organ the alterations have become so great, through fusion of some parts and suppression or exaggeration of others, that it is not possible to select a fundamental pattern from which all others may be derived, but, instead, many of these must be recognized.

With regard to the taxonomic value of this organ in birds the evidence is conflicting. Much of it tends to support the conclusion that it is of little or no value, since, either from similarity of diet or due to convergent evolution, appearances of affinity are formed where no true relationship exists. Furthermore, differences in structure are seen in closely allied birds where presumably the diet is the same.

On the other hand, in many families, in spite of changes in response to diet a uniform and characteristic pattern is traceable which gives definite indications of affinity and provides valuable taxonomic features. Among the groups in which this is true are the Ardeidae, Phoenicopteridae, Anatidae, Picidae, Trichoglossidae, Buteonidae, Falconidae, Trochilidae, and possibly the Meliphagidae, Bucconidae, Ramphastidae, Corvidae, and Nectariniidae. To these with more study, others may be added.

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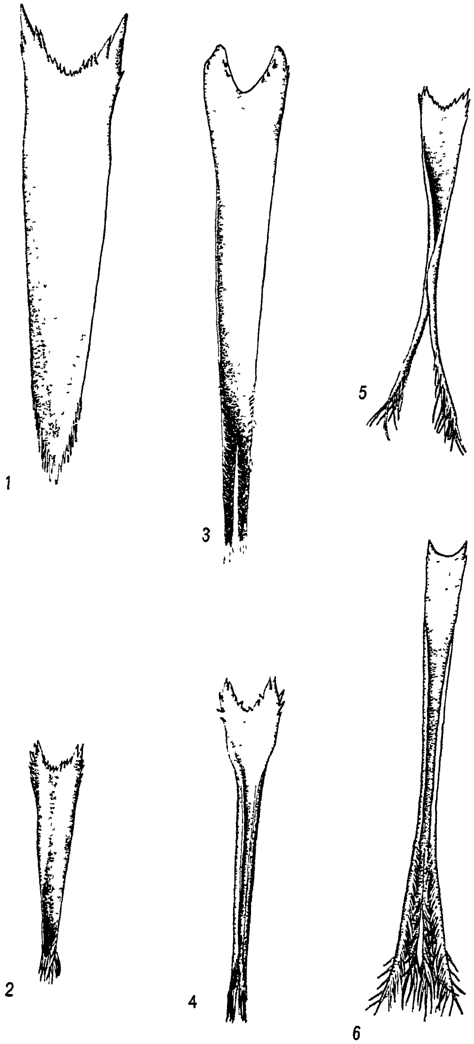
## EXPLANATION OF FIGURES ILLUSTRATING BIRD TONGUES

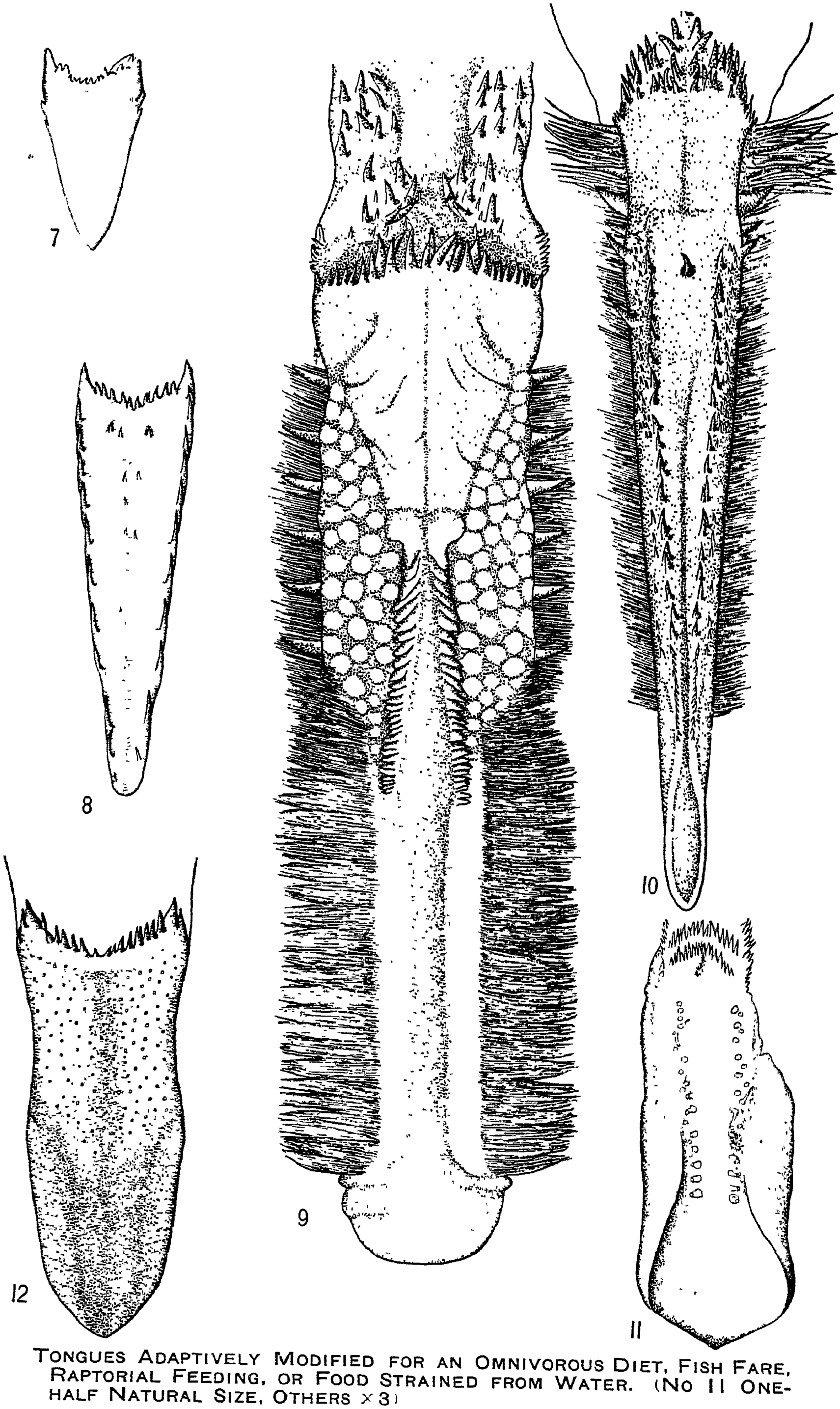
### PLATE 1

No. 1. *Planesticus migratorius.*
2. *Dendroica tigrina.*
3. *Icterus icterus.*
4. *Chlorophanes spiza.*
5. *Coereba bananivora.*
6. *Myzomela rubratra.*



Series Illustrating Multiple Tubular Tongues, Modifications of a Generalized Type Pattern. (X3)

For explanation of plate see page 5



Tongues Adaptively Modified for an Omnivorous Diet, Fish Fare, Raptorial Feeding, or Food Strained from Water. (No 11 One-half Natural Size, Others × 3)

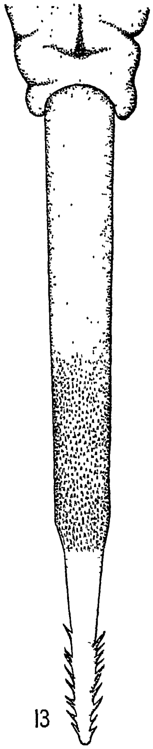
For explanation of plate see page 8

PLATE 2

No. 7. *Callipepla squamata.*
8. *Puffinus griseus.*
9. *Querquedula cyanoptera.*
10. *Mergus serrator.*
11. *Phoenicopterus ruber.*
12. *Buteo lineatus elegans.*

PLATE 3

No. 13. *Xenopicus albolarvatus.*  
14. *Colaptes cafer collaris.*  
15. *Melanerpes formicivorus bairdii.*  
16. *Sphyrapicus thyroideus.*  
17. *Conurus auricapillus.*  
18. *Carpodacus cassini.*  
19. *Hemignathus procerus.*  
20. *Anhinga anhinga.*  
21. *Pyrotrogon neglectus.*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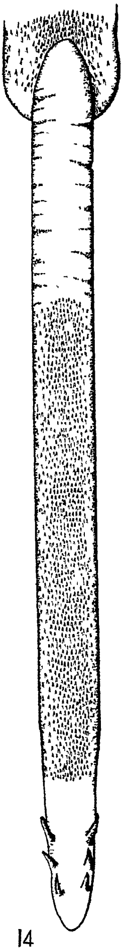
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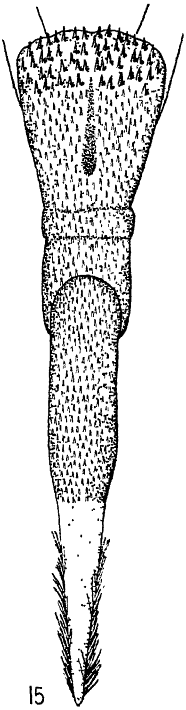
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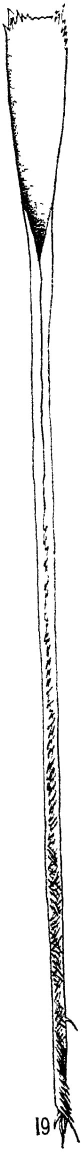
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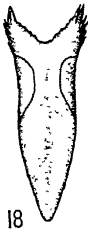
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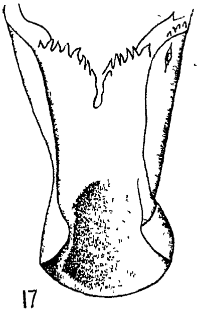
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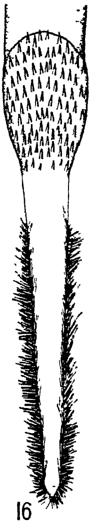
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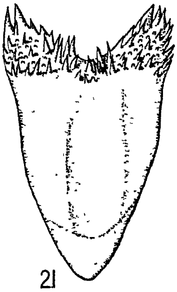
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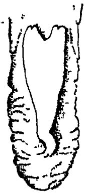
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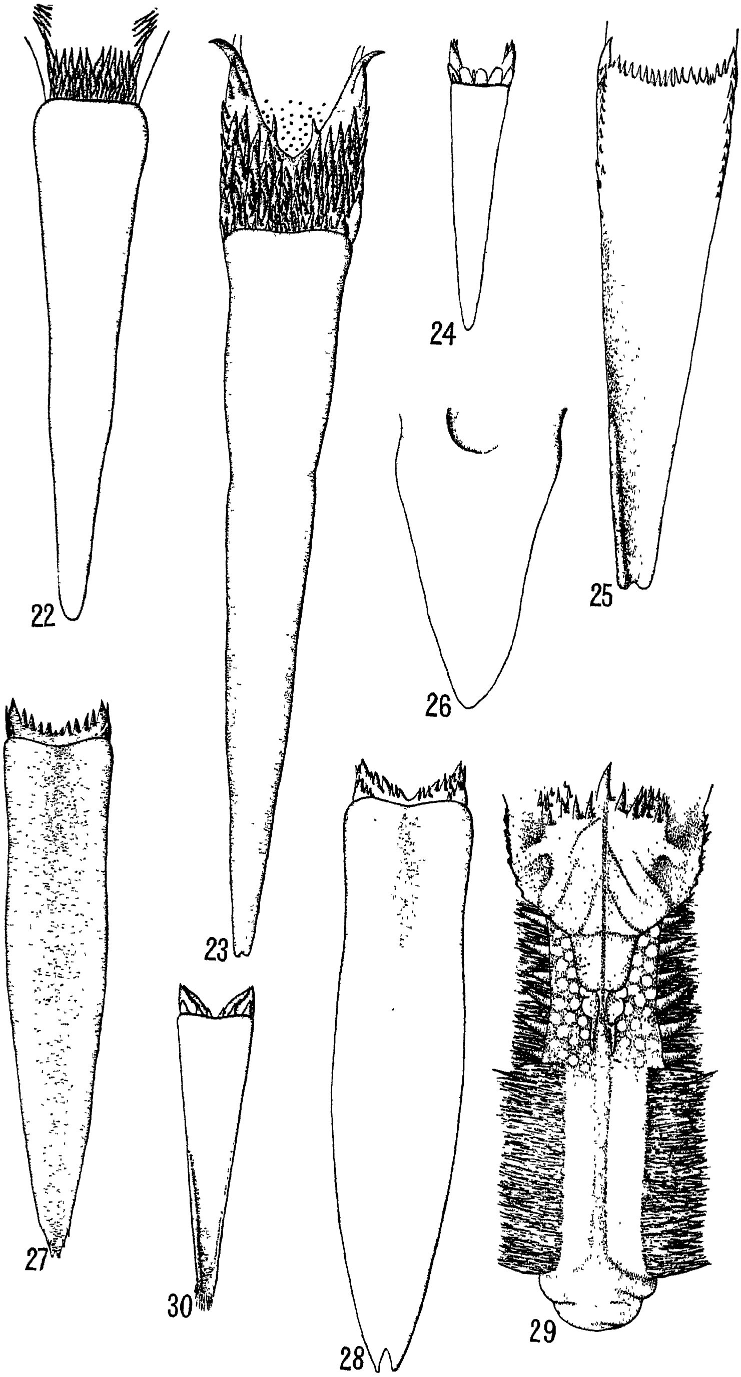
Spearing Tongues, Tongues of Seed and Fruit Feeders, Flower Frequenters, and Rudimentary Types. (×3)

For explanation of plate see page 9



TONGUES OF VARIOUS WATER BIRDS (×2)

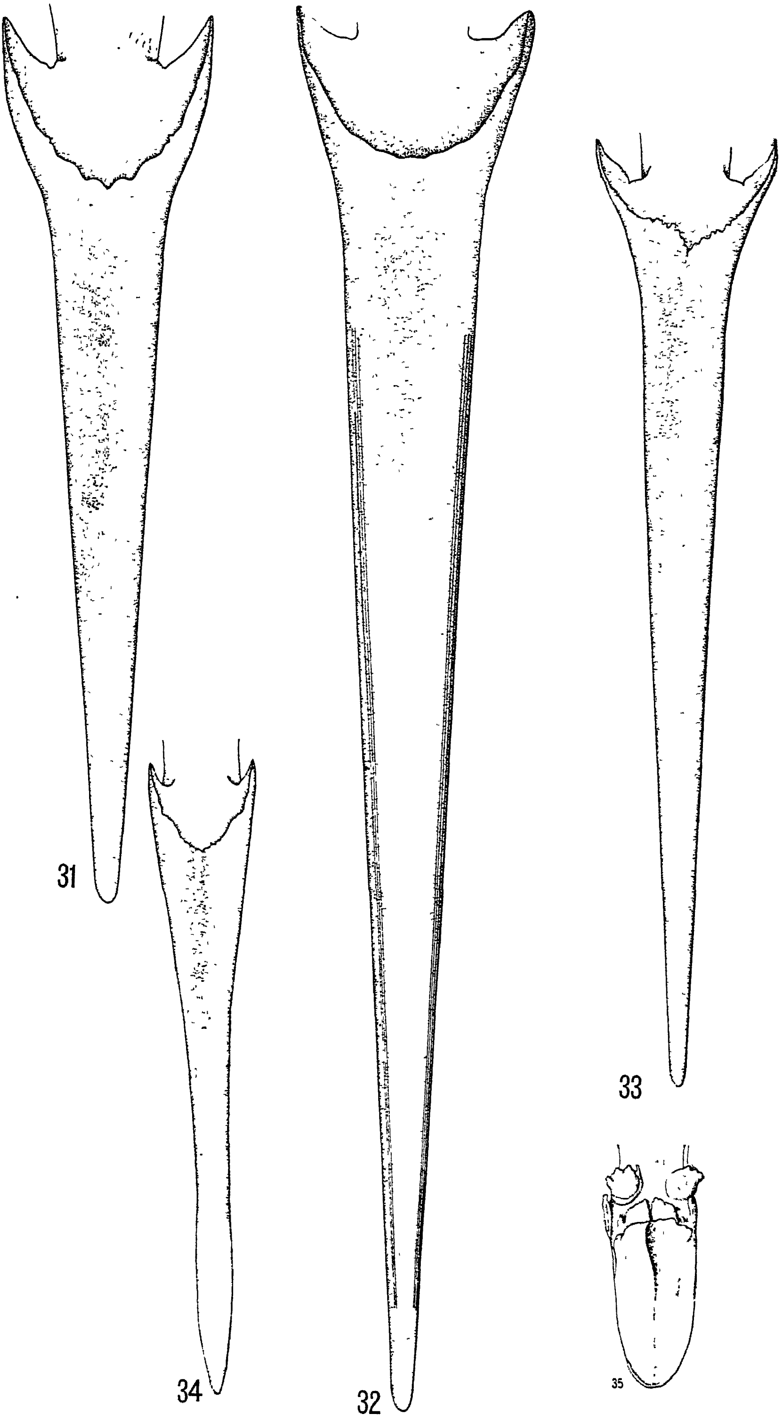
FOR EXPLANATION OF PLATE SEE PAGE 11

## PLATE 4

No. 22. *Gavia pacifica.*
23. *Gavia immer.*
24. *Colymbus nigricollis californicus.*
25. *Fulmarus glacialis glupischa.*
26. *Ciconia ciconia.*
27. *Larus heermanni.*
28. *Larus occidentalis.*
29. *Erismatura jamaicensis.*
30. *Gallinula galeata.*

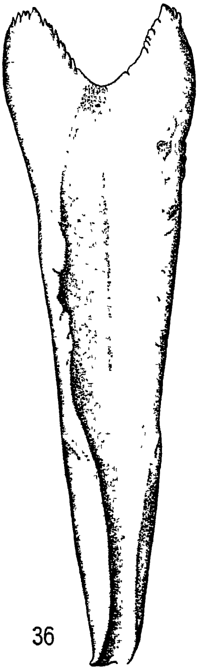
PLATE 5

No. 31. *Nycticorax naevius.*
32. *Ardea herodias.*
33. *Botaurus lentiginosus.*
34. *Butorides virescens anthonyi.*
35. *Cereopsis novaehollandiae.*



Tongues of Various Birds. (No. 35 Natural Size, Others × 2)

For explanation of plate see page 13



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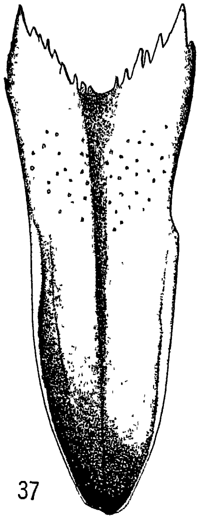

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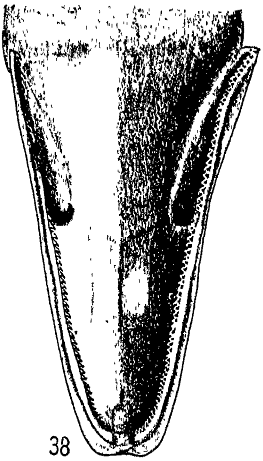

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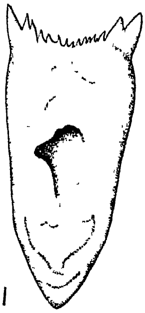

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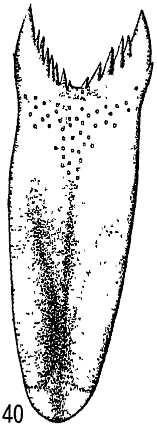

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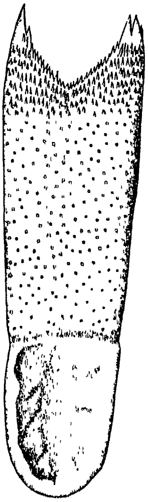

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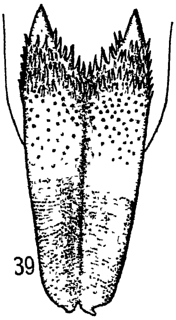

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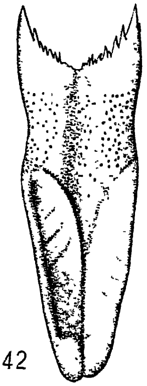

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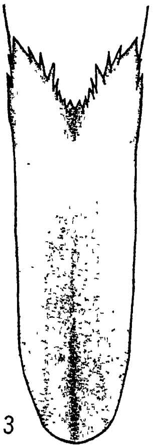

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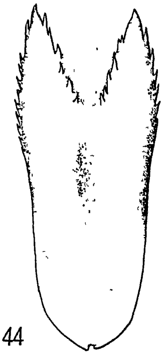

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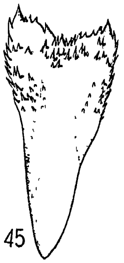

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TONGUES OF VARIOUS BIRDS. (No. 42 ×2, OTHERS ×3)

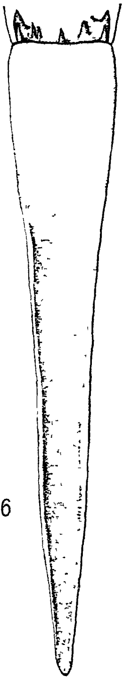
FOR EXPLANATION OF PLATE SEE PAGE 15

### PLATE 6

No. 36. *Gypaëtus barbatus.*
37. *Buteo borealis calurus.*
38. *Cathartes aura septentrionalis.*
39. *Falco sparverius phalaena.*
40. *Circus hudsonius.*
41. *Polyborus plancus.*
42. *Buteo albicaudatus.*
43. *Accipiter cooperi.*
44. *Surnia ulula.*
45. *Opisthocomus cristatus.*
201. *Chrysolophus pictus.*

## PLATE 7

No. 46. *Heteroscelus incanus.*
47. *Rallus levipes.*
48. *Limnodromus griseus scolopaceus.*
49. *Aramus vociferus.*
50. *Recurvirostra americana.*
51. *Rynchops nigra.*
52. *Eurypyga helias.*
53. *Fulica americana.*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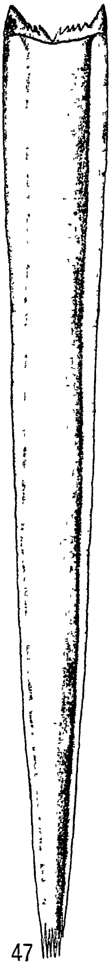
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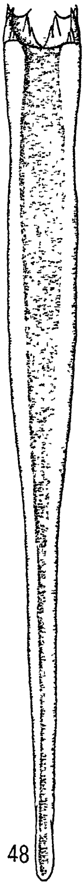
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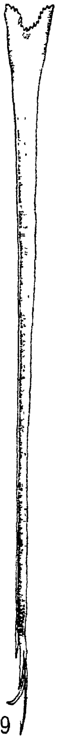
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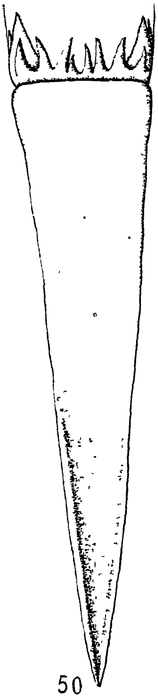
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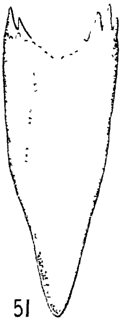
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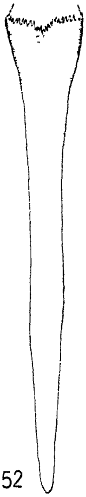
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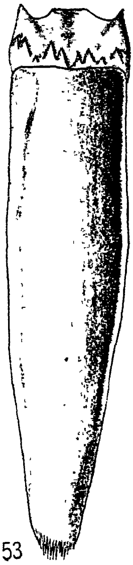
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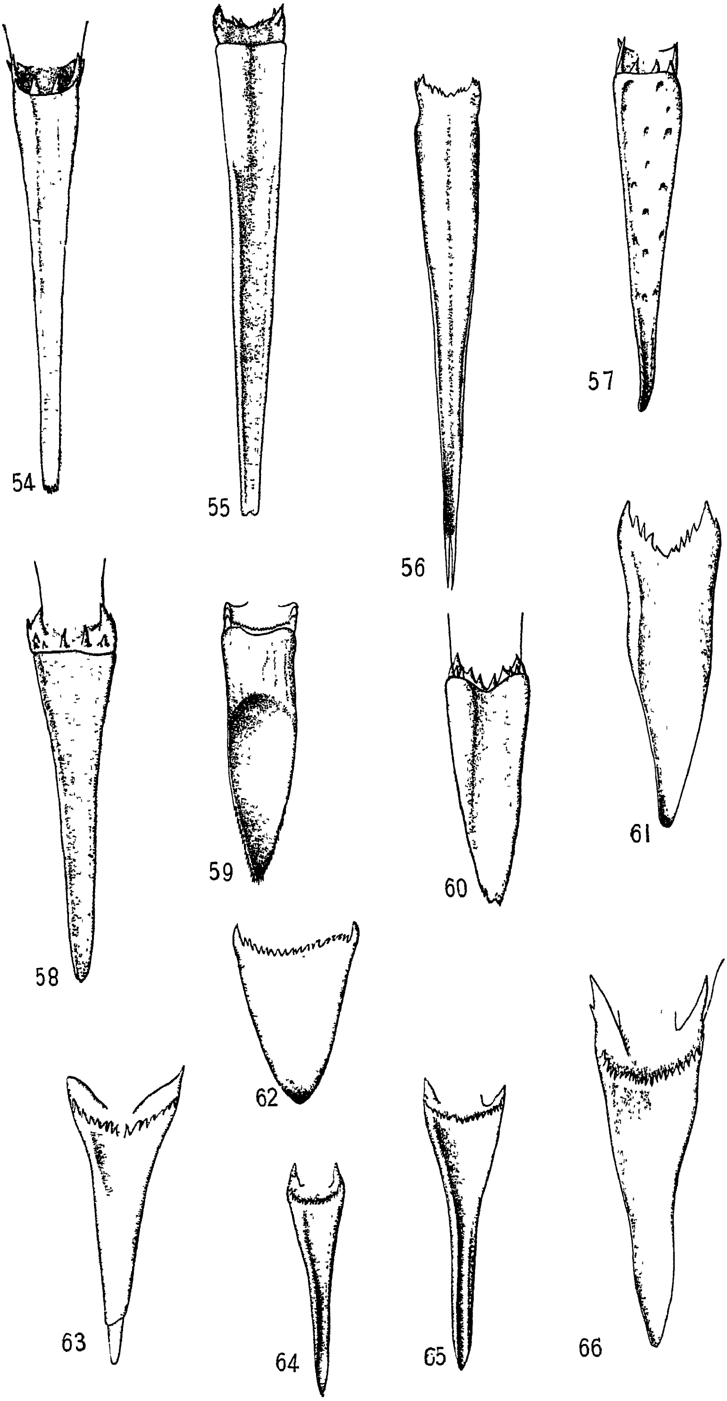
TONGUES OF GRUIFORMES AND CHARADRIIFORMES (NOS. 49 AND 52 × 2, OTHERS × 3)

FOR EXPLANATION OF PLATE SEE PAGE 16



TONGUES OF VARIOUS BIRDS. (NOS. 59 AND 61 × 2, OTHERS × 3)

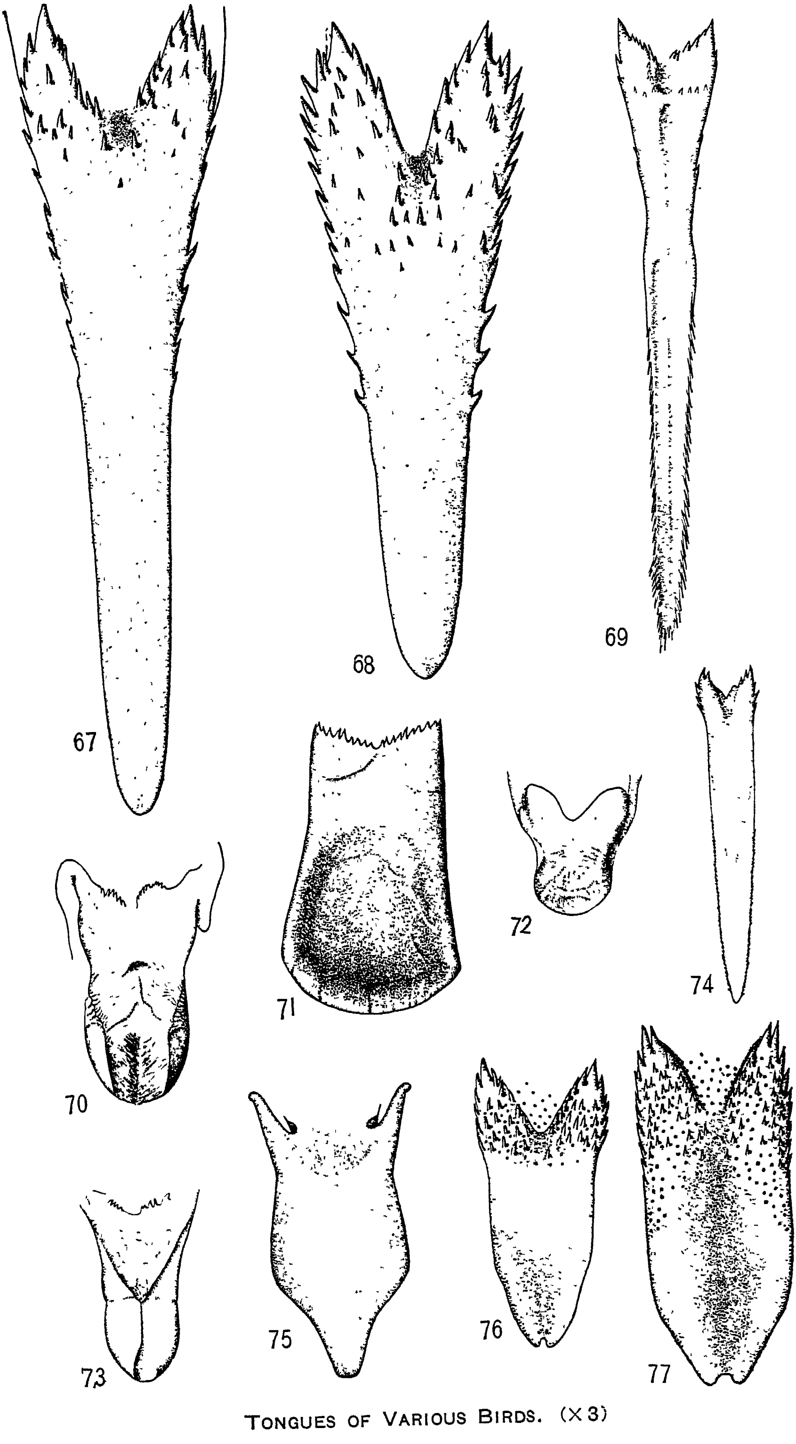
FOR EXPLANATION OF PLATE SEE PAGE 17

## PLATE 8

No. 54. *Actitis macularia.*
55. *Sterna antillarum.*
56. *Sterna forsteri.*
57. *Ereunetes pusillus.*
58. *Oxyechus vociferus.*
59. *Ionornis martinica.*
60. *Charadrius semipalmatus.*
61. *Haematopus palliatus.*
62. *Colinus virginianus cubensis.*
63. *Histriophaps histrionica.*
64. *Geopelia cuneata.*
65. *Zenaida vinaceorufa.*
66. *Columba gymnophthalma.*

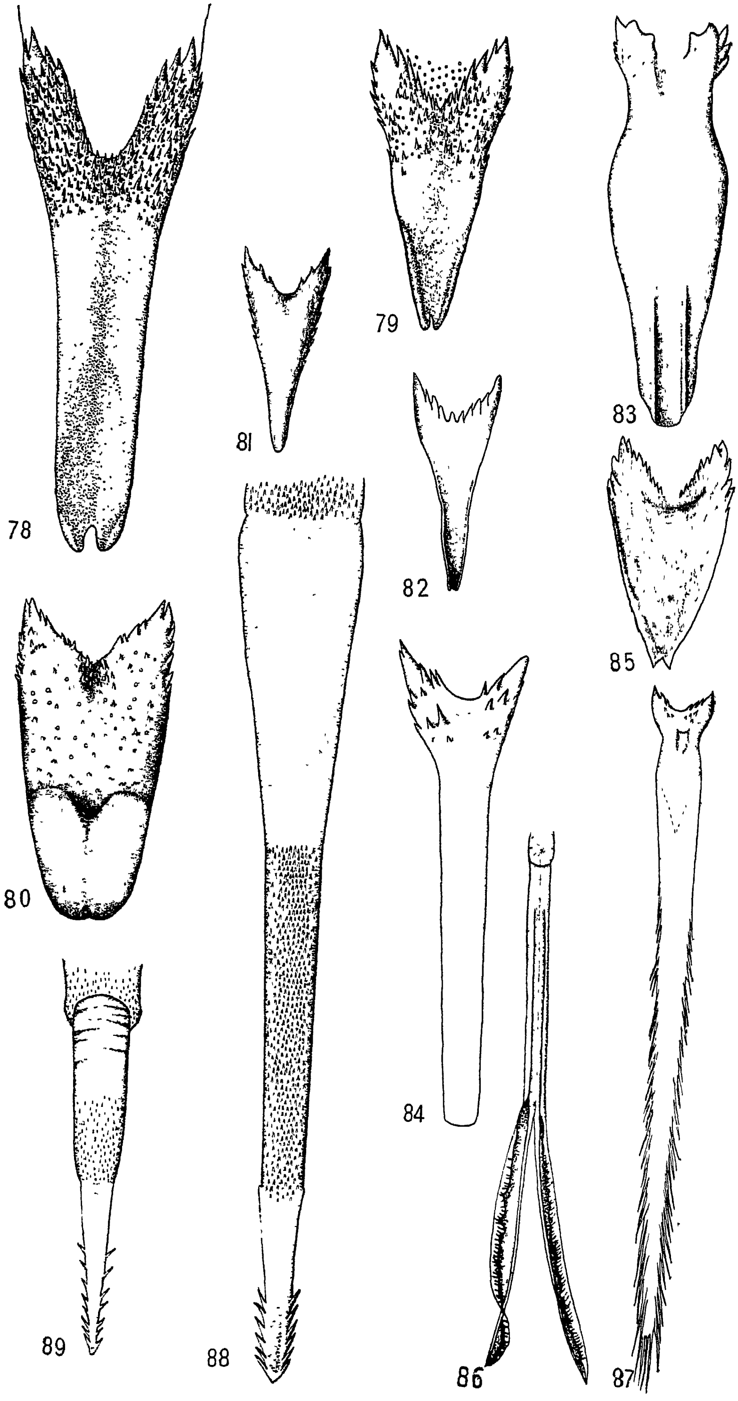
## PLATE 9

No. 67. *Geococcyx californianus.*
68. *Geococcyx californianus,* (to show differences in length).
69. *Saurothera dominicensis.*
70. *Psitteuteles chlorolepidota.*
71. *Aprosmictus cyanopygius.*
72. *Melopsittacus undulatus.*
73. *Calopsitta novaehollandiae.*
74. *Todus multicolor.*
75. *Ceryle alcyon.*
76. *Speotyto cunicularia hypugaea.*
77. *Asio wilsonianus.*



TONGUES OF VARIOUS BIRDS. (×3)

FOR EXPLANATION OF PLATE SEE PAGE 18



TONGUES OF CAPRIMULGI. (×3)

FOR EXPLANATION OF PLATE SEE PAGE 19

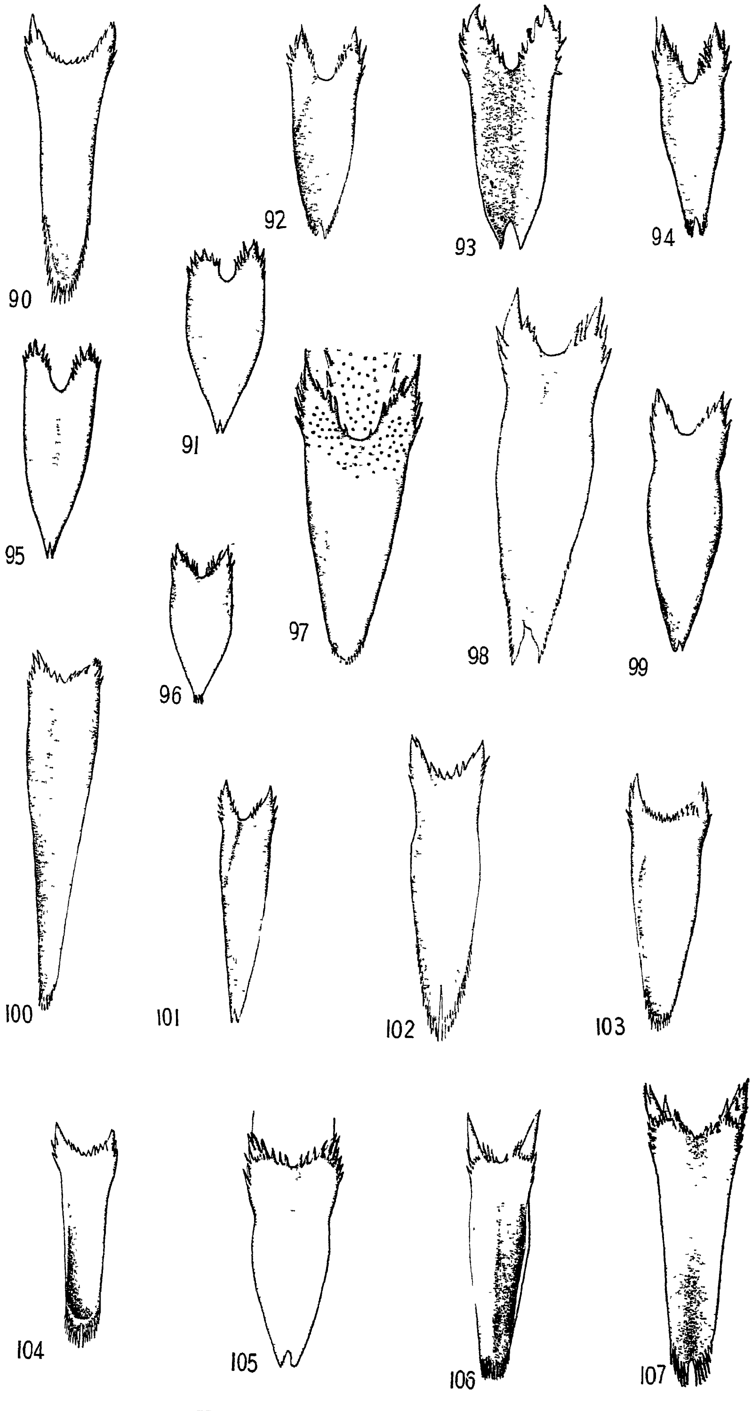
## PLATE 10

No. 78. *Tyto pratincola.*

79. *Otus asio bendirei.*
80. *Spiloglaux novaezealandiae.*
81. *Chordeiles acutipennis texensis.*
82. *Macropteryx coronata.*
83. *Bucco bicinctus.*
84. *Lophoceros melanoleucus.*
85. *Collocalia,* sp (from Lucas).
86. *Calypte anna.*
87. *Pteroglossus frantzii.*
88. *Dryobates villosus hyloscopus.*
89. *Dryobates nuttalli.*

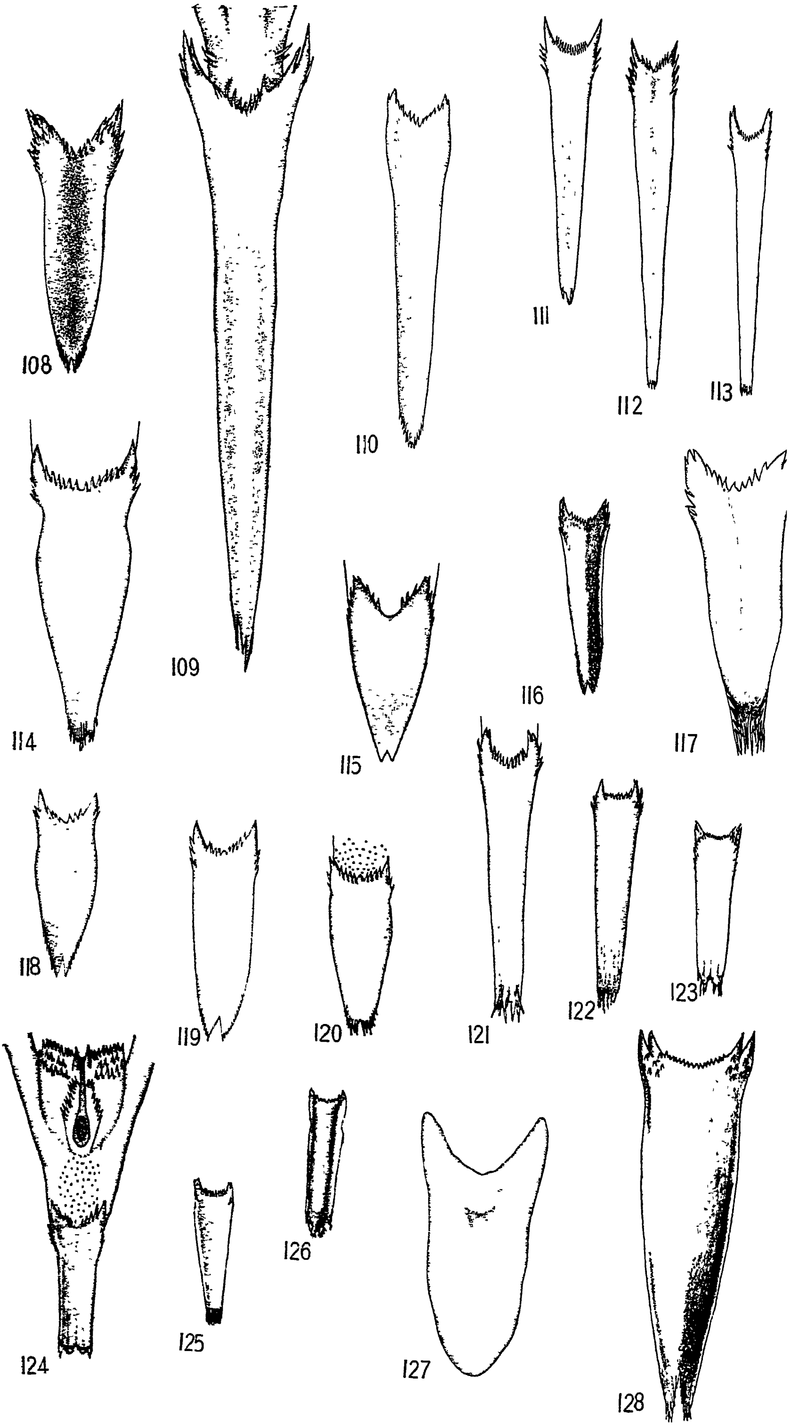
## Plate 11

No. 90. *Pitta erythrogaster.*
91. *Myiochanes richardsoni.*
92. *Pyrocephalus rubinus mexicanus.*
93. *Sayornis sayus.*
94. *Sayornis nigricans.*
95. *Nuttallornis borealis.*
96. *Empidonax griseus.*
97. *Tyrannus verticalis.*
98. *Tolmarchus gabbi.*
99. *Myiarchus dominicensis.*
100. *Furnarius agnatus.*
101. *Sittasomus*, sp.
102. *Gymnocichla nudiceps.*
103. *Thamnophilus bridgesi.*
104. *Oligura superciliaris.*
105. *Myadestes townsendii.*
106. *Hylocichla guttata.*
107. *Mimus polyglottos leucopterus.*



TONGUES OF PASSERIFORMES. (× 3)

FOR EXPLANATION OF PLATE SEE PAGE 23



Tongues of Passeriformes. (× 3)

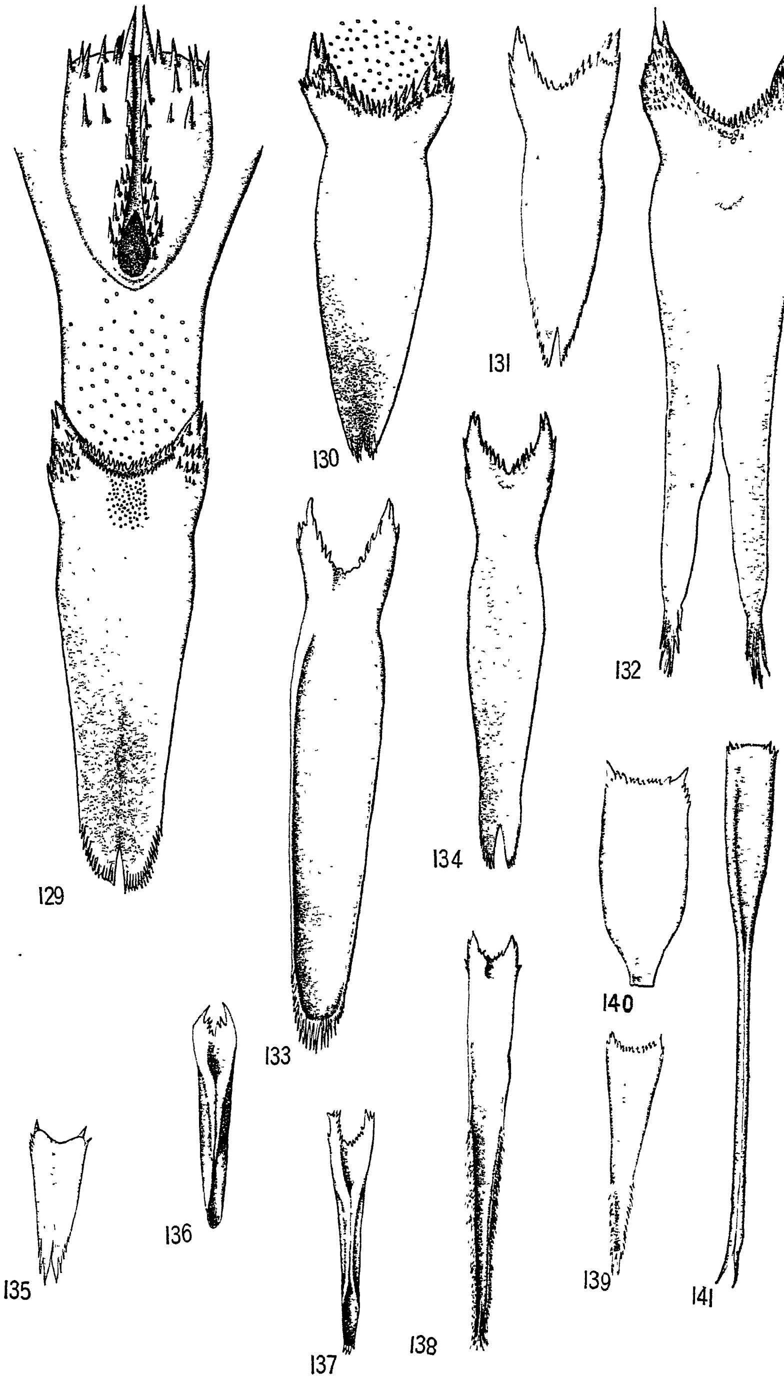
For explanation of plate see page 25

### PLATE 12

No. 108. *Sialia mexicana.*
109. *Toxostoma redivivum pasadenense.*
110. *Cinclus mexicanus.*
111. *Thryomanes bewicki charienturus.*
112. *Catherpes mexicanus punctulatus.*
113. *Certhia familiaris zelotes.*
114. *Lanius ludovicianus gambeli.*
115. *Petrochelidon lunifrons.*
116. *Polioptila caerulea obscura.*
117. *Dulus dominicus.*
119. *Vireo,* sp.
118. *Lawrencia nana.*
120. *Vireo belli pusillus.*
121. *Sitta carolinensis aculeata.*
122. *Sitta pygmaea.*
123. *Penthestes gambeli baileyae.*
124. *Baeolophus inornatus.*
125. *Psaltriparus minimus californicus.*
126. *Auriparus flaviceps.*
127. *Xanthoura luxuosa* (apparently injured).
128. *Aphelocoma californica.*

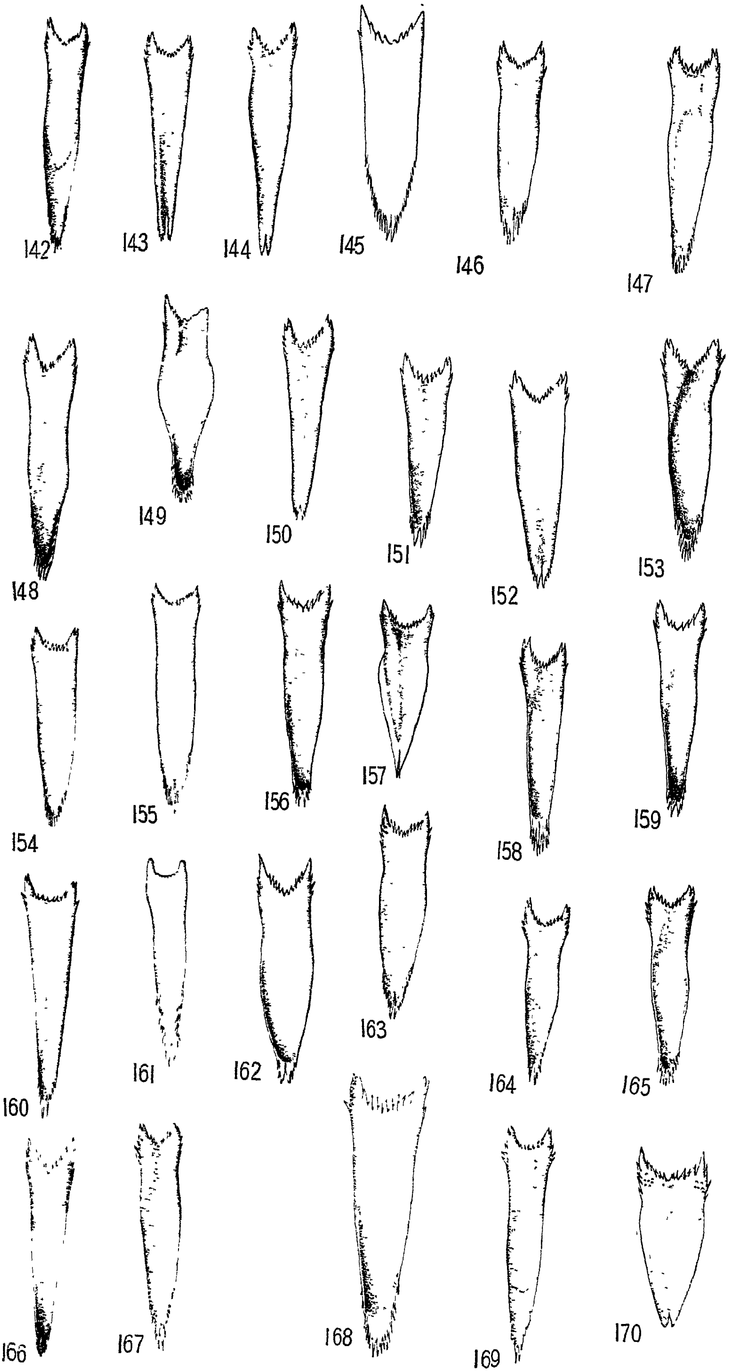
## PLATE 13

No. 129. *Pica nuttalli.*
130. *Cyanocitta stelleri frontalis.*
131. *Scissirostrum dubium.*
132. *Nucifraga columbiana.*
133. *Strepera graculina.*
134. *Sturnella neglecta.*
135. *Zosterops atrifrons.*
136. *Telespyza cantans.*
137. *Passerculus rostratus.*
138. *Cyanerpes cyanea.*
139. *Chalcoparia phoenicotis.*
140. *Psittarostra psittacea.*
141. *Hermotimia,* sp.



Tongues of Passeriformes. (No. 133 × 2, Others × 3)

For explanation of plate see page 26



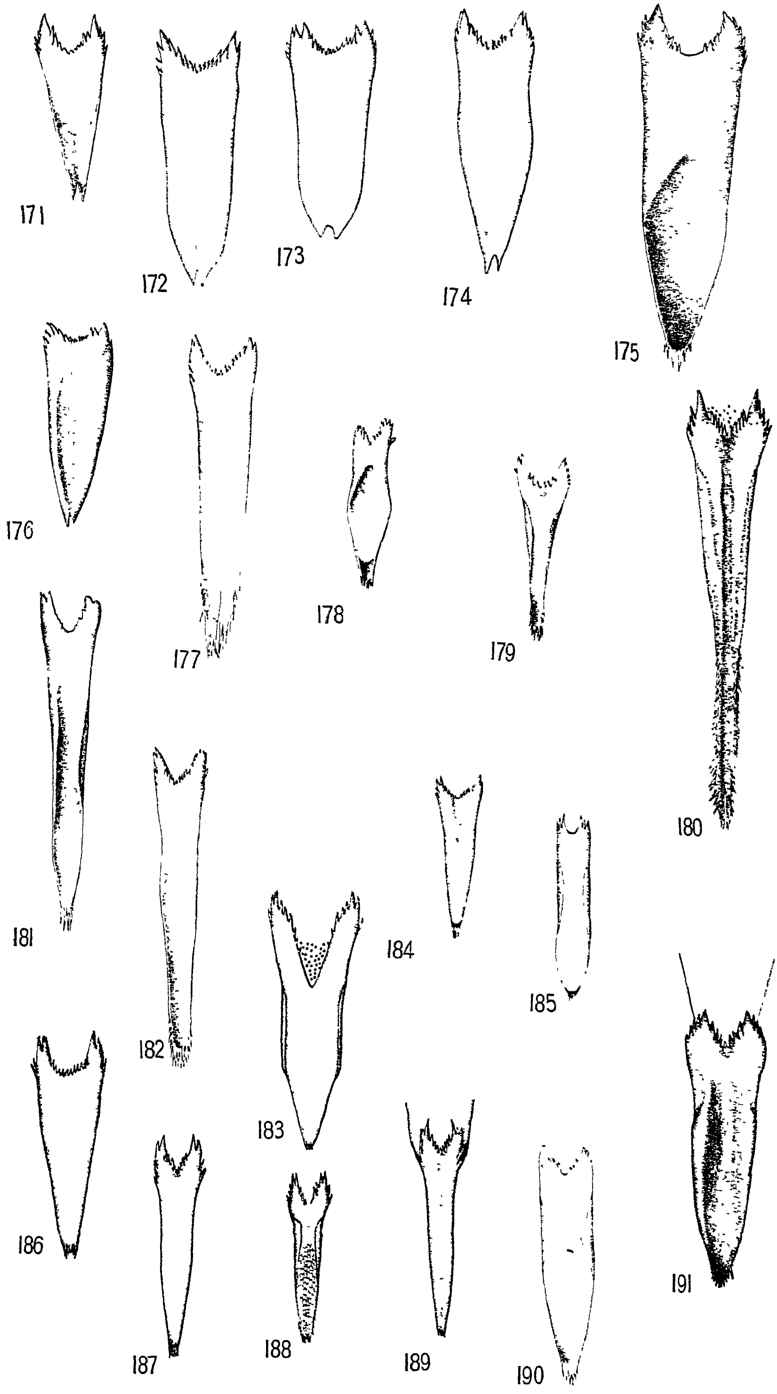
TONGUES OF PASSERIFORMES. (×3)

FOR EXPLANATION OF PLATE SEE PAGE 29

No. 142. *Dendroica dominicia.*
143. *Vermivora celata lutescens.*
144. *Dendroica petechia gundlachi.*
145. *Catharopeza bishopi.*
146. *Dendroica occidentalis.*
147. *Dendroica palmarum.*
148. *Granatellus franciscae.*
149. *Wilsonia canadensis.*
150. *Certhidea salvini.*
151. *Dendroica nigrescens.*
152. *Dendroica auduboni.*
153. *Dendroica vigorsii.*
154. *Dendroica discolor.*
155. *Dendroica petechia.*
156. *Dendroica striata.*
157. *Dendroica castanea.*
158. *Dendroica fusca.*
159. *Dendroica virens.*
160. *Teretistris fernandinae.*
161. *Teretistris fornsi.*
162. *Wilsonia citrina.*
163. *Wilsonia p. pileolata.*
164. *Vermivora luciae.*
165. *Compsothlypis americana.*
166. *Oporornis tolmiei.*
167. *Oreothlypis gutturalis.*
168. *Icteria virens.*
169. *Helmitherus vermivorus.*
170. *Tachyphonus*, sp.

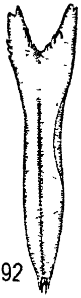
## PLATE 15

No. 171. *Tanagra* (*Euphonia*) *violacea.*
172. *Thraupis darwini.*
173. *Stephanophorus leucocephalus.*
174. *Ramphocelus brasilius.*
175. *Pitylus grossus.*
176. *Tanagra,* sp.
177. *Phaenicophilus poliocephalus.*
178. *Munia punctulata.*
179. *Steganura paradisea.*
180. *Icterus cucullatus nelsoni.*
181. *Molothrus atronitens.*
182. *Pseudoleistes,* sp.
183. *Passer domesticus.*
184. *Tiaris olivacea.*
185. *Loxia leucoptera.*
186. *Oberholseria chlorura.*
187. *Ammodramus savannarum bimaculatus.*
188. *Spinus pinus.*
189. *Passerculus savannarum alaudinus.*
190. *Oryzborus,* sp.
191. *Zamelodia melanocephala.*



TONGUES OF PASSERIFORMES. (X 3)

FOR EXPLANATION OF PLATE SEE PAGE 30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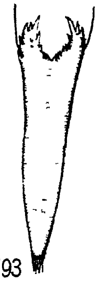
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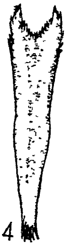
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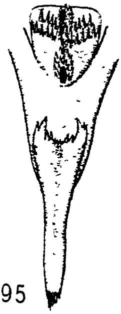
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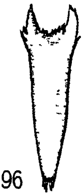
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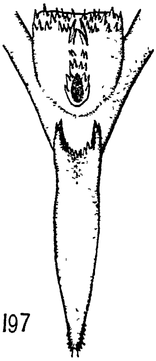
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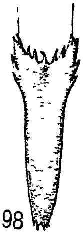
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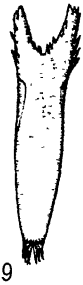
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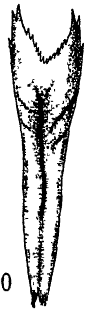
200

TONGUES OF PASSERIFORMES. (×3)

FOR EXPLANATION OF PLATE SEE PAGE 30

## PLATE 16

No. 192. *Pipilo aberti.*
193. *Chondestes grammacus strigatus.*
194. *Passerculus beldingi.*
195. *Amphispiza belli.*
196. *Spizella passerina arizonae.*
197. *Passerella iliaca stephensi.*
198. *Junco hyemalis thurberi.*
199. *Passerella iliaca.*
200. *Pipilo crissalis senicula.*

○

# A REVISION OF THE INSECTS OF THE APHID GENUS AMPHOROPHORA

By Preston W. Mason

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This paper represents principally a systematic study of the aphid genus *Amphorophora* Buckton. There has also been included what is known of the biology of each species. The meager facts that are available indicate very forceably the need of rearing work in connection with any systematic study in this family of insects.

The genus was erected by Buckton in British Aphides[1] for a new species which he described on the same page. Since that time various other species have been added by other writers. Several authors have discussed the species common to their own State or country, but the species of this genus of the entire world have never been brought together in one paper. The present writer has attempted to do this here.

In this work I have had the use of all specimens in the United States National Museum and the Bureau of Entomology; the collection of the Maine Agricultural Experiment Station, loaned by Dr. Edith M. Patch; the Swain collection of Leland Stanford University, loaned by Prof. G. F. Ferris; a part of the Canadian collection loaned by William Ross; and the private collections of W. M. Davidson, Dr. Thomas Guyton, and Harold Morrison. Prof. J. J. Davis has kindly loaned certain slides from his collection and from the Monell collection. Prof. E. O. Essig has loaned specimens from the University of California. Prof. R. Takahashi sent Japanese material. The National collection contains metatype slides of certain of Van der Goot's species. Frederick Laing and Prof. F. V. Theobald have discussed through correspondence the European species and Professor Takahashi the Japanese and Formosan species. Prof. O. W. Oestlund has compared drawings sent to him with species discussed by him in his report of 1887.

Certain aphid workers who have visited Washington recently have examined some of the slides with the writer and expressed their opinions as to the identity of the species. These include Miss Patch and Messrs. Ross, Guyton, Davidson, and Potgieter.

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[1] Vol. 1, 1876, p. 187.

No. 2592.—Proceedings U. S. National Museum, Vol. 67, Art. 20.
43328—25——1

Dr. A. C. Baker of this Bureau, under whose immediate direction the work has been done, has given many valuable suggestions and has helped in many ways. The writer also wishes to thank Dr. A. L. Quaintance for making it possible to undertake the work.

### Genus AMPHOROPHORA

*Amphorophora* Buckton, British Aphides, vol. 1, 1876, p. 187.
*Macrosiphum* Oestlund, Minn. Geol. Survey Rept., no. 14, 1886, p. 27.
*Macrosiphum* Del Guercio, Nuove Rel. Staz. Firenze, ser. 1, 1900, no. 2, p. 159.
*Nectarosiphon* Schouteden, Ann. Ent. Soc. Belg., ser. 5, vol. 45, 1901, p. 112.
*Eunectarosiphon* Del Guercio, Redia, vol. 9, 1913, p. 188.
*Rhopalosiphum* Van der Goot, Tijd. voor Ent., vol. 56, 1913, p. 146.

The above is copied from Baker's Generic Bulletin.[2] For a discussion of this synonymy see Baker's paper. The species *convolvuli* Kaltenbach, which he refers to *Amphorophora* in his discussion proves to be a *Myzus*, according to letters received by the writer from both Laing and Theobald.

I am of the opinion that Baker's characterization of the genus should be modified so as to exclude certain species in which the antennal tubercles are covered with small scales or imbrications. Tubercles of this type may be either converging or diverging. I am excluding these species from my conception of *Amphorophora* and leaving them for a future study.

The antennae are usually longer than the body, dark colored in the majority of the species, and imbricated. The sensoria are subcircular and vary greatly in number in the different species, some having only a row on segment III, while other species have segments III, IV, and V thickly covered. The hairs are plainly capitate on some species. In other species they are indistinctly so, if at all. The hairs are sometimes nearly as long as the width of segment III, while in other species they are very minute.

The antennal tubercles are very prominent in most species, but occasionally are almost wanting on the outer side.

The beak usually reaches about to the second coxae, but may be longer.

The wing venation is normal. Some *Amphorophorus*-like species have a brownish tinge to the veins but most of these fall in the group with imbricated antennal tubercles, which I am excluding from the genus. A few species are dusky near the tip of the wing.

The legs are very long, the posterior ones being much longer than the length of the body.

The cornicles are long, much longer, as a rule, than the cauda. I have given considerable latitude to the amount of dilation, some being very prominently swollen, others being very slender, but at the same time, plainly dilated. There is a distinct distal flange in all species. One group of species has the tip of the cornicles very conspicuously reticulated. Another group has no reticulations, but often two or more lines or imbrications. Certain species are intermediate between the reticulated and imbricated ones. Some have small scales or imbrications over most of the length of the cornicle, while in others these organs have an almost smooth surface.

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[2] U. S. Dept. Agr. Bull. 826, p. 54.

The shape of the cauda varies from those that are strongly constricted to those that are conical. The number of hairs on the cauda differs in the different species, but, as a rule, there are 2 to 4 sets of lateral ones.

Tubercles are not conspicuous in the genus as a whole, but several species show prothoracic, lateral ones. A few species have them on the lateral margins of the abdominal segments. One species has two dorsal ones on the head and two on the dorsum of the prothorax.

Intermediates between the alate and apterous forms appear to be fairly common in the genus as I have seen them in three species, *nabali* Oestlund, *sensoriata* Mason, and *essigwanai*, new name.

The type of the genus is *Amphorophora ampullata* Buckton, which is described in British Aphides.[3] It was taken on the fronds of *Cystopteris montana*. The type slide still exists in the British Museum and contains three apterous viviparous females. A very similar species was taken from ferns on the American continent, and drawings of it were sent to Frederick Laing for comparison. He says in private correspondence that in all of the type specimens of *ampullata* "the sensoria reach nearly the length of Segment III and number from 30–34." The species from this continent, he says, seems to be the same as one which he reared in England from a fern and the same as Van der Goot described as *ampullata* Buckton.[4] I learn from correspondence with Professor Oestlund that his 1887 description of *ampullata* Buckton is of the same species. William's *ampullata* Buckton? (1910) is very probably the same, but I can not tell from his description, and his specimens seem to be lost. There is also in the National Collection the same form from Takahashi. It is probable that all references in literature to *ampullata* Buckton, except those cataloguing the original description, refer to this new form. Laing writes that he had given to this new form a provisional varietal name, but suggests that the writer fix the status as he thinks best. In view of the differences in the number and position of the sensoria on Segment III of the apterous viviparous female, it is my opinion that it is entitled to standing as a distinct species, and it is described in this paper as *A. laingi*, new species. *A. ampullata* Buckton, therefore, at present is known only from the type slide.

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[3] Vol 1, p. 187.

[4] Beit. Z. Kennt. der Holland, Blattläuse (1915).

The genus *Amphorophora* seems to be world-wide in its distribution. From data at hand various species of the genus are found in North America, South America, Europe, Africa, India, and Japan.

Certain groups of plants are favored as hosts. The genus *Rubus* has eight of the species discussed in this paper. *Ribes* has four species. In the family Ericaceae the genus *Vaccinium* has one, *Gaultheria* one, *Epigoea* one, *Azalea* one, and *Rhododendron* two species. The family Compositae is host to five species. This family is known to be the summer host of one of these five and will probably prove to be the same for the others. The Coniferae furnish hosts for one species in this country and one in England.

There are practically no data on the alternation of hosts in this genus. Only one, and probably two species are known to have alternate hosts. Some of the others seem to live on the same plants throughout the year.

Very little can be said on the origin and phylogeny of the group, as the species are too imperfectly known at present. I am not in a position to say where the genus originated or on what plant. In fact, I can not be absolutely certain that I am dealing with a phyllogenetic group. It seems probable that those species on a certain host group originated from a common ancestor, as they seem to be rather closely related.

In the group of forms mentioned as living on Compositae there are several very closely related ones. These include *cosmopolitana* (*lactucae* Kaltenbach), *carduellinum* Theobald, *oleraceae* v. d. Goot, *formosana* Takahashi, *sonchifoliae* Takahashi. There are also some other specimens in the National Collection which could be described as new species with about as much difference as is given for most of the species mentioned, but I hesitate to do this until more is known of them. This group is so closely related that it is often difficult to place an individual specimen. There should be extensive rearings to settle definitely the number of species concerned. Until this is done I am retaining as valid species those which have been described, with the exception of *sonchifoliae* Takahashi. He admits that it is very near *oleraceae* v. d. Goot, but his differences do not hold when checked against metatype specimens.

Certain species which have been placed in this genus by various writers are not included here, since they belong to the group mentioned as having imbricated antennal tubercles. These include *rhinanthi* Schouteden, *subterrans* Wilson, *magnoliae* Essig and Kuwana, *lonicericola* Takahashi, and *hydrangeae* Matsumura.

Other species properly belonging to *Megoura* have been placed in *Amphorophora* at times and there is some evidence for considering *Megoura* as a synonym of *Amphorophora*. However, I have decided to retain it as a valid genus, separating the two on the shape of the cornicles. In *Megoura* they are practically the same thickness from the base to the center, after which they narrow to the flange. This often gives the center the appearance of a slight bulge. In *Amphorophora* the cornicle narrows considerably between the base and the swollen central portion, giving an actual, conspicuous dilation.

In the tables of measurements the first line for each specimen refers to the left side, such as left antenna or left cornicle.

When a species is described from one specimen only, this specimen is designated as the type.

When a species is described from several specimens, all from the same colony, these specimens are designated as cotypes, and there is no type.

When a species is described from several specimens taken from different colonies, either in the same or different localities, the specimens from one colony are designated as cotypes, those from the other colonies as paracotypes.

The following keys will help to separate the species. It has been necessary to omit *betae* from the keys as no specimens were available for study and the published description does not give sufficient details.

### KEY TO ALATE VIVIPAROUS FEMALES[5]

| | | |
|---|---|---|
| 1. | Cornicles distinctly reticulated | 2 |
| | Cornicles not reticulated, often imbricated at tip | 15 |
| 2. | Cornicles shorter than segment III of antennae | 3 |
| | Cornicles equal to or longer than segment III | 11 |
| 3. | Segment III of antennae light colored | **corylina** (Davidson). |
| | Segment III of antennae dark colored | 4 |
| 4. | Segment IV longer than V | 5 |
| | Segment IV shorter than V | 10 |
| 5. | Cornicles not longer than width of head through eyes | 6 |
| | Cornicles considerably longer than width of head through eyes | 8 |
| 6. | Segment IV with sensoria | **brittenii** (Theobald). |
| | Segment IV without sensoria | 7 |
| 7. | Cauda with about six lateral hairs. Cornicles very broad. | **essigwanai**, new name. |
| | Cauda with about two lateral hairs. Cornicles more slender (On *Aconitum*) | **aconiti** (v. d. Goot). |
| 8. | III with a row of about 16 sensoria | **vaccinii**, new species. |
| | Antennae with numerous senoria | 9 |
| 9. | V with 14–15 senoria | **hayhursti**, new species. |
| | V with 5–10 sensoria | **mitchelli**, new species. |
| 10. | Smallest diameter of cornicle one-half of widest diameter (On Spiraea). | **spiraecola** (Patch). |
| | Smallest diameter of cornicle two-thirds of widest diameter (On *Rubus*). | **reticulata**, new species. |
| 11. | IV with sensoria | **brittenii** (Theobald). |
| | IV without sensoria | 12 |

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[5] Roman numerals refer to the number of the segment of the antenna, as segment III.

12. III with 9–11 senoria in a row (On *Cupressus*) ........ **morrisoni** (Swain).
III with 13–45 sensoria (On *Rubus*) ........ 13
13. Antennae light colored ........ **maxima,** new species.
Antennae dark colored ........ 14
14. III with 20–30 sensoria and noticeably shorter than cornicle. Distinct dusky spot on tip of wing ........ **rubicola** (Oestlund).
III with 34–42 sensoria and subequal with cornicle, tip of wing with a faint dusky border ........ **davidsoni,** new species.
15. Cornicles slightly longer than segment III ........ **nervata** (Gillette).
Cornicles not longer than III ........ 16
16. Cornicles distinctly shorter than IV ........ 17
Cornicles not shorter than IV ........ 22
17. IV without sensoria ........ 20
IV with sensoria ........ 18
18. V with 0–3 sensoria (On *Rubus*) ........ **sensoriata** Mason.
V with 5–8 sensoria ........ 19
19. Hairs on antennae capitate and about as long as width of segments **pergandei,** new species.
Hairs inconspicuous, shorter than width of segment ........ **carduellina** (Theobald).
20. Cornicles considerably swollen (On Ferns) ........ **laingi,** new species.
Cornicles slender, less swollen ........ 21
21. III with 21–31 sensoria ........ **vagans** (v. d. Goot).
III with 30–50 sensoria (On *Rubus*) ........ **rubi** (Kaltenbach).
22. Cornicles longer than width of head through eyes ........ 23
Cornicles equal to or shorter than width of head through eyes ........ 27
23. Antennae very tuberculate ........ 24
Sensoria in a straight row ........ 25
24. Cornicles three times base of VI ........ **braggi,** new species.
Cornicles more than four times base of VI ........ **nabali** (Oestlund).
25. With sensoria on IV and V ........ **minima,** new species.
Without sensoria on IV and V ........ 26
26. Cauda with about 4 lateral hairs ........ **cicutae** Shinji.
Cauda with 2 lateral hairs ........ **nervata** (Gillette).
27. III with 6–8 sensoria ........ **solani** (Thomas).
Antennae tuberculate ........ 28
28. IV with about 27 sensoria. V with 12 sensoria ........ **oleraceae** (v. d. Goot).
IV with 9–19 sensoria. V with 1–7 sensoria ........ **cosmopolitana,** new name.

### KEY TO APTEROUS VIVIPAROUS FEMALES

1. Cornicles distinctly reticulated ........ 2
Cornicles not reticulated, often imbricated at tip ........ 13
2. Cornicles much shorter than segment III ........ 3
Cornicles not shorter than III ........ 5
3. III with about 25 sensoria over nearly entire length ........ **aconiti** (v. d. Goot).
III with less senoria ........ 4
4. III with 2–3 sensoria near base. Cauda with 2 lateral hairs. **pallida,** new species.
III with 6–8 sensoria ........ **essigwanai,** new name.
5. Cornicles much longer than III ........ 6
Cornicles subequal with III ........ 8
6. III with 13–15 sensoria ........ **rubicola** (Oestlund).
III with 1–6 small sensoria ........ 7
7. Cauda as broad as antennal tubercles ........ **morrisoni** (Swain).
Cauda not as broad as antennal tubercles ........ **rhododendronia,** new species.

8. Cauda not constricted, with 2 or 3 lateral hairs -------- 9
Cauda long, slightly constricted, with 3 lateral hairs -------- 10
9. Cauda with 2 sets of lateral hairs -------- **alni**, new species.
Cauda with 3 sets of lateral hairs -------- **azaleae**, new species.
10. Antennae and cornicles dark colored -------- 11
Segment III and cornicles lighter -------- 12
11. Widest diameter of cornicles about one half length of base of VI. **borealis**, new species.
Widest diameter of cornicles more nearly one-third length of base of VI. **vaccinii**, new species.
12. III about twice the width of head through eyes -------- **spiraecola** (Patch).
III about one and one-half times the width of head through the eyes. **rhododendronia**, new species.
13. III half as long again as cornicles -------- 23
III shorter -------- 14
14. III with 40–50 sensoria -------- **nabali** (Oestlund).
III with 0–30 sensoria -------- 15
15. III without sensoria -------- **nervata** (Gillette).
III with sensoria -------- 16
16. III with 1–2 sensoria -------- 17
III with 4–30 sensoria -------- 19
17. Cornicles black -------- **formosana** Takahashi.
Cornicles green or white -------- 18
18. Cornicles green. On Pine -------- **evansi** Theobald.
Cornicles white. On *Polia* -------- **takahashii**, new species.
19. IV and V with sensoria -------- 20
IV and V without sensoria -------- 21
20. III with 17–20 sensoria. IV with 3–6 sensoria -------- **carduellina** Theobald.
III with 22–28 sensoria. IV with 10 sensoria. V with 4–6 sensoria. **oleraceae** (v. d. Goot).
21. Cauda long, broad, not constricted, hairs shorter than width -------- 25
Cauda constricted, with hairs longer than width -------- 22
22. Antennae with capitate hairs as long as width of segments. **pergandei**, new species.
Hairs inconspicuous, much shorter than width of segments. **cosmopolitana**, new name.
23. III with 7–18 sensoria grouped near base -------- **laingi**, new species.
III with sensoria along entire length -------- 24
24. Very large species. On Ferns -------- **ampullata** Buckton.
Smaller species. On *Rubus* -------- **sensoriata** Mason.
25. Unguis of VI distinctly longer than III (1⅔ times longer). **zhuravlevi** Mordvilko.
Unguis of VI shorter or subequal with III -------- 26
26. Cornicle light colored. Cauda with 5–6 lateral hairs -------- **rubi** (Kaltenbach).
Cornicle dark. Cauda with 3–4 lateral hairs -------- **amurensis** Mordvilko.

### AMPBOROPHORA ACONITI (Van der Goot)

Figs. 169–173

*Rhopalosiphum aconiti* VAN DER GOOT, Tijdschr. voor Ent., vol. 55, 1912, p. 73; Beiträge zur Kenntnis der Holländischen Blattläuse, 1915, p. 140.—THEOBALD, The Entomologist, vol. 50, 1917, p. 81.—WILSON and VICKERY, Trans. Wisconsin Acad. Sci. Arts and Letters, vol. 19, pt. 1, p. 29.

One alate and one apterous specimen, sent by Van der Goot, are available for study.

*Alate viviparous female.*—The antennal segments are as follows:

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 1.264 mm. | 49 | 0.688 mm. | 0.608 mm. | 8+(?) mm. |
| 1.280 mm. | 50 | 0.688 mm. | 0.560 mm. | -------------- |

The sensoria of segment III are tuberculate and evenly distributed throughout nearly the entire length. Other segments without secondary sensoria. VI with a group of six small sensoria adjacent to the larger one. IV and V faintly imbricated, V more distinctly so toward the tip. I slightly gibbous on inner side. Head 0.608 mm. wide through the eyes. Antennal tubercles fairly prominent. Beak reaching nearly to second coxae. Cornicles 0.624 mm. long, distinctly reticulate for a distance of 0.16 mm.; largest diameter, 0.088 mm.; smallest diameter, 0.064 mm.; flange, 0.08 mm. The cauda is twisted in our specimen, but Van der Goot states that it is of the same length as the cornicles. There appears to be two sets of lateral hairs. Spiracles and hairs of abdomen as shown in figure 172.

*Apterous viviparous female.*—The only specimen we have is in very poor condition. The single antenna present is slightly longer than the body, the segments being as follows:

| III | IV | V | VI |
|---|---|---|---|
| 1.184 mm. | 0.624 mm. | 0.56 mm. | 0.128+(0.8+) |

The third segment has about 25 sensoria scattered over nearly the entire length. The head is 0.608 mm. wide through the eyes. The antennal tubercles are distinct.

The beak reaches almost to the third coxae. The one cornicle which is present is 0.64 mm. long, being distinctly reticulated for a distance of 0.128 mm.; widest diameter, 0.096 mm.; narrowest diameter, 0.064 mm.; flange, 0.08 mm. Theobald says they are variable in form, some being almost cylindrical. The cauda is twisted; Van der Goot says that it is of the same length as the cornicles. His figure shows it to be broad and not constricted.

*Host.*—*Aconitum napellus.*

*Distribution.*—Holland, Bergedorf near Hamburg, Germany (determinations verified by Van der Goot), and Yorkshire, England.

*Metatype.*—Deposited in the U. S. National Museum.

### AMPHOROPHORA ALNI, new species

Figs. 1–3

*Apterous viviparous female.*—Antennae longer than body, slender; hairs shorter than width of segments, one to three small sensoria near base of III, antennal measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 896<br>0. 864 | 3<br>3 | 0. 736<br>0. 752 | 0. 720<br>0. 688 | 0. 192+1. 088<br>0. 192+1. 088 |
| 2 | 0. 768<br>0. 720 | 1<br>2 | 0. 672<br>0. 640 | 0. 656<br>0. 640 | 0. 160+0. 992<br>0. 192+1. 072 |
| 3 | 0. 832<br>0. 832 | 1<br>1 | 0. 720<br>0. 688 | 0. 656<br>0. 656 | 0. 192+1. 072<br>0. 176+ (?) |

Antennal tubercles large and prominent. Capitate hairs present on vertex and on basal antennal segments. Beak reaching third coxae. Cauda long, broad, not constricted, with two sets of lateral hairs. Cornicles very long, moderately swollen on distal half, distinctly reticulate at tip.

| No. | Head | Cauda | Cornicles | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 496 | 0. 368 | 0. 864<br>0. 864 | 0. 064<br>0. 064 | 0. 104<br>0. 096 | 0. 048<br>0. 048 | 0. 064<br>0. 072 |
| 2 | 0. 480 | 0. 352 | 0. 800<br>0. 800 | 0. 080<br>0. 064 | 0. 096<br>0. 088 | 0. 048<br>0. 048 | 0. 064<br>0. 064 |
| 3 | 0. 496 | 0. 368 | 0. 880<br>0. 880 | 0. 096<br>0. 080 | 0. 112<br>0. 112 | 0. 048<br>0. 048 | 0. 064<br>0. 064 |

*Last Instar Apterous Nymph*

| Head | III | IV | V | VI | Cornicles | |
|---|---|---|---|---|---|---|
| | | | | | Length | Width |
| 0. 384 | 0. 528 | 0. 496 | 0. 512 | 0. 16+0. 928 | 0. 640 | 0. 112 |
| | 0. 512 | 0. 528 | 0. 512 | 0. 16+0. 960 | 0. 640 | 0. 080 |
| 0. 352 | 0. 544 | 0. 480 | 0. 512 | 0. 16+0. 928 | 0. 640 | 0. 064 |
| | 0. 560 | 0. 512 | 0. 480 | 0. 16+0. 896 | 0. 576 | 0. 112 |

Described from specimens submitted by Miss Patch, taken at Orono, Me., on *Alnus incana,* August 7, 1916 (Maine No. 127–16). Three apterous viviparous females and several nymphs. No alates.

One apterous viviparous female was also taken at Orono on *Alnus incana* on June 26, 1909 (Maine No. 45–09), and one in 1904 (Maine No. 48–04 Sub. A).

*Cotypes.*—Deposited in the U. S. National Museum, Cat. No. 26370. Paracotypes in the Maine Agricultural Experiment Station.

### AMPHOROPHORA AMPULLATA Buckton

*Amphorophora ampullata* BUCKTON, Brit. Aph., vol. 1, 1876, p. 187.—LICHTENSTEIN, Les. Puc. Aph., 1885, p. 19.—KIRKALDY, Can. Ent., vol. 37, 1905, p. 415.—WILSON, Ann. Ent. Soc. Amer., vol. 3, 1910, p. 320.—PATCH, Maine Agr. Exp. Sta. Bull. 202, 1912, p. 180.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 33.

This is the type species of the genus. The type slide (bearing three apterous viviparous females) exists in the British Museum. Frederick Laing writes that segment III of these specimens have from 30–34 sensoria, reaching nearly the length of the segment. Drawings kindly loaned by him show the hairs of III to be less than half the width of the segment and capitate. The cornicle is shown to be about three-fifths as long as III, moderately slender, conspicuously swollen, and with no reticulations or imbrications.

As explained on page 3, this species is known only from the type slide.

### AMPHOROPHORA AMURENSIS Mordvilko

*Acyrthosiphon* (*Amphorophora*) *rubi amurense* MORDVILKO, Fauna de la Russie, vol. 1, liv. 2, 1919, p. 267.

Mordvilko described this form as a subspecies of *rubi* Kaltenbach. I have not seen it, but judging from his description it is a good species. It may be separated from its near relatives by the characters given in the key on page 54. I quote herewith a translation of Mordvilko by A. J. Bruman.

*Apterous viviparous female.*—Body spindle shaped. Depth of frontal furrow is two-sevenths to one-third the distance between the bases of the antennae. Antennal tubercles quite convex. The projection of the vertex is distinct. Antennae only slightly longer than the body (one and one-twenty-fifth to one and one-fourteenth times). The third segment is one and one-fourth to one and one-third times longer than the fourth, and the fourth nearly that many times longer than the fifth. The base of the sixth segment is one-sixth to two-thirteenths the length of the third, and the tip of the sixth is only very slightly less than the length of the third segment (for instance eleventh-twelfths of that length). The capitate hairs on the third segment reach four-fifths to three-fifths the diameter of the proximal part of the segment. Near the base this segment has 6–12 secondary sensoria. The cornicles reach two-ninths to one-fourth the length of the body. At a distance of one-third from the end they are swollen. From here toward the base they first become narrow and then at the very base they widen considerably. In front of the flange there is another slight (hardly noticeable) swelling. No sculpture is seen on the walls of the cornicles. The cauda is two to two and one-half times shorter than the cornicles, elongated—triangular, at times with a weak constriction at some distance from the base. On each side there are usually four bristly hairs, at times on one side only three hairs. Size of body, 3.25–1.23 mm.; 4.21–1.44 mm. Color green or light green (may be inclined toward light brick or light reddish). Antennae dark, brownish with the exception of the base of the third segment which is somewhat lighter. The cornicles are dark tawny, darker toward the end (almost black) and lighter toward the base. The ends of the femora are dark; the ends of the tibiae and tarsi are brown. Eyes reddish brown. The color of the extremities is generally darker than in the other subspecies of *rubi* Kaltenbach.

*Measurements of two specimens.*—4.14–1.44: Frontal furrow, 0.07; between the base of the antennae, 0.26; mouth of furrow, 0.19; width of furrow at the middle of its depth, 0.15, at base, 0.10; central vertex projection, 0.011; hairs on each side, 0.060; antennae, 4.49; with the following lengths of segments: 0.17, 0.10, 1.23, 0.98 (0.96), 0.75 (0.73), 0.19 (0.20)+1.07 (1.09). Hairs on third segment up to 0.040; diameter of the proximal part of the segment, 0.053. Sensoria, 10 (6). Cornicles, 1.02; their thickness 0.12 (base), 0.066 (0.38 from base), 0.11 (0.32 from end), 0.53 (0.05 from end), 0.060 (0.03 from end), 0.056 (in front of flange), 0.066 (flange). Cauda, 0.43; its thickness 0.20 (base), 0.14 (0.24 from end); on each side 3–4 bristly hairs. Posterior femora, 1.53; tibia, 2.74; tarsi, 0.14 (0.04: 0.12), claws, 0.046, hairs on tibia, 0.029–0.063; diameter of proximal part of tibia, 0.066.

4.03–1.44: Frontal furrow, 0.08; between basis of antennae, 0.26; mouth of furrow, 0.15; width of furrow at the middle of its length, 0.12, at base, 0.08. Projection of vertex, 0.010; hairs on its side, 0.056. Antennae, 4.39; with the following lengths of segments: 0.17, 0.10, 1.21 (1.16), 0.93 (0.94), 0.73, 0.19+1.06. Hairs on the third segment, 0.027–0.035, diameter of the proximal part of the segment, 0.054. Sensoria near the base of this segment, 9 (12). Cornicles, 0.90; their thickness, 0.12 (base), 0.073 (0.27 from base), 0.11 (0.26 from end), 0.055 (0.04 from end), 0.056 (0.02 from end), 0.053 (in front of flange), 0.073 (flange). Cauda, 0.45; its thickness 0.21 (base), 0.15 (0.32 from end), 0.16 (0.29 from end), 0.15 (0.20 from end); on each side of the cauda are four bristly hairs. Posterior femora, 1.57; tibia, 3.08; tarsus, 0.14 (0.04, 0.11); claws 0.043, hairs on tibia, 0.040–0.060; diameter of proximal part of tibia, 0.073.

This form differs from the European (*rubi* Kaltenbach) in the darker coloration of the antennae, legs, and cornicles, frequently by a more constant small, hardly noticeable swelling of the cornicles in front of the flange and by the lesser number of hairs on the sides of the cauda (in the specimens which I examined there were not more than four on each side). Apparently the North American *Microsiphum rubicola* Oestlund, at least by its dark coloration of the antennae and cornicles stands closest of all to *Ac. rubi amurense.*

*Distribution.*—The subspecies is known so far only from the shores of the lower Amur.

*Habits.*—These aphids were collected from the ends of shoots and from the under side of the leaves of raspberry. Their life habits are apparently similar to those of *Ac. rubi rubi.*

### AMPHOROPHORA AZALEAE, new species

*Apterous viviparous female.*—Body light colored. Antennae about one and one-half times as long as body, dark; the tips of the segments and all of segment VI darker; hairs very small and inconspicuous; III, with 2–3 sensoria near base. Antennal tubercles prominent. Spines on head small. Cornicles dark colored, long and slender, slightly swollen, the tips distinctly reticulated. Cauda light colored, broad, and conical, not constricted, with three sets of rather small lateral hairs. Measurements as follows:

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 0. 688<br>0. 672 | 3<br>2 | 0. 464<br>0. 464 | 0. 480<br>0. 512 | 0. 144+0. 368+<br>0. 144+0. 496 |

| Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0. 415 | 0. 288 | 0. 672<br>0. 672 | 0. 048<br>0. 048 | 0. 064<br>0. 064 | 0. 040<br>0. 040 | 0. 048<br>0. 048 |

Described from one adult apterous viviparous female and several alate and apterous nymphs taken on *Azalea indica* in a nursery at Glen St. Mary, Fla., February 23, 1924, by W. T. Owrey.

*Host.*—*Azalea indica.*

*Distribution.*—Florida.

*Cotypes.*—Deposited in U. S. National Museum. Cat. No. 26945.

### AMPHOROPHORA BETAE (Theobald)

*Rhopalosiphum betae* THEOBALD, Journ. Bd. Agr., vol. 19, no. 11, 1913, p. 918.

*Macrosiphum betae* (Theobald) WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 42.

I have not seen this species. Judging from Theobald's figures it probably should be included in this genus.

*Host plants.*—Beets and mangolds.

*Distribution.*—England.

### AMPHOROPHORA BOREALIS, new species

Figs. 109–111

Received from Dr. Edith M. Patch one slide bearing a single adult apterous viviparous female and several very small nymphs (Maine No. 101–18), taken on checkerberry at Orono, Me., June 26, 1918. Doctor Patch had given this species the manuscript name of *borealis*, but gave the writer the privilege of describing it in this paper. Her manuscript name is adopted.

*Apterous viviparous female.*—Antennae slightly longer than body, basal segments nearly concolorous with body, distal segments darker, III with a single sensorium near base, hairs inconspicuous, shorter than width of segment. Antennal tubercles large and heavy. Beak reaching beyond second coxae. No prothoracic or abdominal tubercles showing. Cornicles dark colored, long, distinctly swollen, tip plainly reticulated, remainder imbricated. Cauda long and broad, distinctly constricted at base; three sets of lateral hairs. Measurements as follows:

| III | IV | V | VI |
|---|---|---|---|
| 0. 576<br>0. 560 | 0. 416<br>0. 416 | 0. 448<br>0. 448 | 0. 144+0. 752<br>0. 144+0. 792 |

| Head | Cauda | Cornicles | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0. 400 | 0. 272 | 0. 560<br>0. 576 | 0. 064<br>0. 064 | 0. 072<br>0. 080 | 0. 032<br>0. 032 | 0. 048<br>0. 048 |

*Host.*—Checkerberry.
*Locality.*—Orono, Maine.
*Cotypes.*—Returned to Maine Agricultural Experiment Station.

### **AMPHOROPHORA BRAGGI, new species**

Figs. 4–6

*Alate viviparous female.*—Antennae slightly longer than body, dark colored, very tuberculate, hairs as long as or longer than width of segment, not plainly capitate. Antennal tubercles rather small. Beak not reaching second coxae. No prothoracic or abdominal tubercles. Abdomen light colored, without lateral dark patches, as in *cosmopolitana*. Cornicles very dark, lighter at base, short, strongly swollen, reticulated but not showing plainly on the black background. Cauda short, strongly constricted, one set of lateral hairs before constriction and three sets beyond constriction. Legs very dark, except bases of femora.

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 1. 072<br>1. 072 | 93<br>87 | 0. 528<br>0. 560 | 35<br>31 | 0. 480<br>0. 496 | 3<br>5 | 0. 112+(0. 784+)<br>0. 112+(0. 768+) |

| Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|
| | | Length | Wide X | Small X | Flange |
| 0. 560 | 0. 336 | 0. 592<br>0. 608 | 0. 136<br>0. 136 | 0. 048<br>0. 048 | 0. 064<br>0. 064 |

Described from a single alate viviparous female taken by L. C. Bragg on lettuce at Marblehead, Mass., October 4, 1920.

This species can be distinguished from *cosmopolitana* on lettuce, by its larger size, more numerous sensoria, darker legs, and by its lighter colored abdomen without lateral dark patches.

*Type.*—Deposited in the U. S. National Museum. Cat. No. 26371.

### AMPHOROPHORA BRITTENII (Theobald)

Figs. 7–9 and 62–66

*Rhopalosiphum brittenii* THEOBALD, Journ. Econ. Biol., vol. 7, 1912, p. 107.—PATCH, Maine Agr. Exp. Sta. Bull. 225, 1914, p. 68.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 46.—JACKSON, The Scot. Natur., 1917, p. 85; 1919, p. 158.

I have not seen this species. The alate and apterous viviparous females are described by Theobald. Miss Jackson (1919) gives a description of the oviparous female.

*Host plants.*—Red and black currants and gooseberries.

*Distribution.*—England, Scotland, Ireland, and Wales.

*Cotypes.*—Deposited in Theobald's collection.

### AMPHOROPHORA CARDUELLINA (Theobald)

Figs. 45–48 and 67–69

*Rhopalosiphum carduellinum* THEOBALD, Bull. Ent. Res., vol. 6, 1915, p. 113.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, p. 49.—THEOBALD, Bull. Ent. Res., vol. 11, 1920, p. 67.

In Theobald's first paper he described the alate form of this species and also described an apterous form. In his second paper he gave another description of an apterous form, stating that his first description referred to another species. Dr. J. T. Potgieter has shown the writer specimens from South Africa which he considers to be this species. The apterous form seems to agree more nearly with the second description of Theobald than with the first one. Doctor Potgieter's specimens however have sensoria on segment V of the antennae. These specimens will be fully described in Doctor Potgieter's forthcoming paper on South African Aphiidae.

The chief difference between this species and *cosmopolitana* seems to be in the presence of sensoria on segment IV and V of the apterous form. In a large series of *cosmopolitana* which I have examined there are sensoria only on segment III. The range of sensoria on segment III of *corduellina* seems to be somewhat greater while in the alate form the range on segment III seems to be somewhat less than in *cosmopolitana*.

The cotype specimens were taken on *Carduus* species in Transvaal in 1914. Those belonging to Doctor Potgieter were taken on *Sonchus* species.

Theobald says in his 1915 paper that the cotypes are deposited in his collection. In his second description of the apterous form (1920) he writes that the cotypes are in the British Museum.

### AMPHOROPHORA CICUTAE Shinji

Figs. 80–84

*Amphorophora cicutae* SHINJI, Can. Ent., vol. 49, 1917, p. 51.

The type of this species was loaned to Dr. A. C. Baker, of this bureau, who made the following manuscript description:

"III, 0.8 mm.; IV, 0.736 mm.; V, 0.56 mm.; VI (0.144 mm. + 1.04 mm.).

"The sensoria (15) form an even row along the segment. They are moderate in size; cornicles, 0.736 mm.; flange, 0.08 mm., narrowest diameter, 0.048 mm.; widest, 0.096 mm.; cauda, 0.32 mm., the extremity extending about to the tip of the cornicles, which have no reticulations at tip but a few transverse imbrications."

This is somewhat different from Shinji's description.

The present location of the type is not known. Essig says in a letter that it must have been taken by Shinji when he left the University of California. No other records of the species have been made.

*Host.*—*Cicuta virosa*, var. *californica*.

*Locality.*—University of California campus, Berkeley, Calif.

*Date of collection.*—April 20, 1915.

### AMPHOROPHORA CORYLINA (Davidson)

Figs. 98–100

*Rhopalosiphum corylinum* DAVIDSON, Journ. Econ. Ent., vol. 7, 1914, p. 134.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918. p. 63.—SWAIN, Univ. Cal. Publ. Tech. Bulls., vol. 3, No. 1, 1919. p. 81.

The following description is from specimens on the type slide.

*Alate viviparous female.*—Antennae longer than body, slender, faintly imbricated, hairs shorter than width of segments. Antennal measurements as follows:

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 0. 800 mm. | 20 | 0. 448 mm. | 0. 496 mm. | 0. 144+0. 832 mm. |
| 0. 752 mm. | 24 | 0. 448 mm. | 0. 464 mm. | 0. 144+0. 864 mm. |
| 0. 688 mm. | 22 | 0. 448 mm. | 0. 448 mm. | 0. 160+0. 792 mm. |
| 0. 672 mm. | 20 | 0. 432 mm. | 0. 448 mm. | 0. 144+0. 768 mm. |

Antennal tubercles prominent. Width of head through eyes, 0.464 mm. Beak reaching second coxae. Cornicles, 0.56 mm. long; reticulate for 0.08 mm.; imbricated; widest diameter 0.064 mm., smallest diameter 0.048 mm.; flange, 0.064 mm.; cauda 0.208 mm. long, conical not constricted, three sets of lateral hairs.

*Pupa, alate viviparous female.*—Antennal measurements:

| III | IV | V | VI |
|---|---|---|---|
| 0. 496 mm. | 0. 288 mm. | 0. 352 mm. | 0. 112+0. 704 mm. |
| 0. 448 mm. | 0. 304 mm. | 0. 336 mm. | 0. 128+0. 688 mm. |
| 0. 512 mm. | 0. 320 mm. | 0. 368 mm. | 0. 112+0. 768 mm. |
| 0. 480 mm. | 0. 320 mm. | 0. 384 mm. | 0. 112+0. 768 mm. |

Cornicles 0.496 mm. long, flanged, slightly swollen.

This species was first recorded from *Corylus.* Davidson recently told me that he doubts if *Corylus* is an important food plant, it being much more common on ninebark.

*Host plants.*—*Corylus rostrata, Physocarpus capitatus.*

*Distribution.*—California.

*Cotypes.*—Deposited in U. S. National Museum. Cat. No. 26854.

### AMPHOROPHORA COSMOPOLITANA, new name

Figs. 14–26 and 33–44

*Aphis lactucae* Kaltenbach, Mongr. der Familien der Pflanzenlause, 1843, p. 37.

*Aphis lactucae* (Linnaeus) Walker, Ann. Nat. Hist., ser. 2, vol. 2, 1849, p. 49.

*Rhopalosiphum ribis* (Linnaeus), Koch, Die Pflanzenlause Aphiden, 1854, p. 39.—Buckton, British Aphides, vol. 2, 1879, p. 9.—Lowe, Geneva Agr. Exp. Sta. Bull. 139, 1897, p. 663.—Van der Goot. Beit. zur Kennt. der Hollandischen Blattlause, 1915, p. 146.

*Rhopalosiphum lactucae* (Kaltenbach) Passerini, Aphididæ Italicae, 1863, p. 20.—Walker, The Zoologist, ser. 2, no. 53, 1870, p. 1997.—Ferrari, Ann. del Mus. Civ. di Stor. Natur. di Genova, vol. 2, 1872, p. 60.—Buckton, British Aphides, vol. 2, 1879, p. 10.—Macchiati, Bull. della Soc. Entom. Ital., vol. 14, 1892, p. 244.—Sanderson, Canad. Ent., vol. 33, 1901, p. 70.—Schouteden, Mem. de la Soc. Entom. de Belg., vol. 12, 1906, p. 236.—Davidson, Journ. Econ. Ent., 1910, p. 377.—Essig, Pomona Journ. Ent., vol. 3, 1911, p. 463.—Theobald, Journ. Econ. Biol., vol. 7, 1912, p. 105.—Patch, Maine Agr. Exp. Sta. Bull. 225, 1914, p. 53.—Mordvilko, Fauna de la Russie, livr. 2, 1914, pp. 51, 58.—Gillette and Bragg, Journ. Econ. Ent., vol. 8, 1915, p. 100.—Dobrovkiansky, A List of Aphids Found on Cultivated Plants in the Government of Kharkov, Bull. on Pests of Agr. Khorkov, 1916.—Tullgren, Meddelande fran Centrolanstalten for Jorsbrukforsch, Entomologiska andelmingen, no. 27, 1916, p. 104.—Theobald, Fruit, Flower and Vegetable Trades Journ. London, Oct. 13, 1917.—Essig, Univ. Cal. Pub. Ent., vol. 1, no. 7, 1917, p. 331.—Quaintance and Baker, U. S. Dept.

Agr. Farm. Bull. 804, 1918, p. 28.—DAS, Mem. Indian Mus., vol. 6, no. 4, 1918, pp. 165, 273.—HAVILAND, Ent. Month. Mag., 1918, p. 201.—DAVIDSON, Journ. Econ. Ent., vol. 11, no. 3, 1918, p. 289.—ESSIG and KUWANA, Proc. Cal. Acad. Sci., vol. 8, no. 3, 1918, p. 35.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, pp. 49, 97.—JACKSON, Scott. Nat., 1918, p. 85; 1919, p. 159.—SWAIN, Univ. Cal. Pub. Tech. Bull., vol. 3, no. 1, 1919, p. 82.—TAKAHASHI, Rev. Formosa Agr. no. 182, 1921, p. 63.—DEL GUERCIO, Redia, vol. 14, 1921, p. 109.

*Siphonophora lactucae* (Linnaeus) THOMAS, 8th Rept., Ill. State Ent., 1879, p. 60.

*Nectarophora lactucae* (Kaltenbach) OESTLUND, Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, pp. 85, 91.—HUNTER, Iowa Agr. Exp. Sta. Bull. 60, 1901, p. 115.

*Siphonophora lactucae* (Kaltenbach) WILLIAMS, Univ. Nebr. Spec. Bull. 1, 1891, p. 16.—SCHOUTEDEN, Ann. de la Soc. Entom. Belg., vol. 44, 1900, pp. 115–119.

*Macrosiphum lactucae* (Kaltenbach) SANBORN, Kans. Univ. Sci. Bull., vol. 3, no. 8, 1906, p. 240.

*Macrosiphum lactucae* Schrank? DAVIS, Bull. Ill. St. Lab. Nat. Hist., vol. 10, 1913, p. 109.

*Amphorophora lactucae* (Kaltenbach) QUAINTANCE and BAKER, U. S. Dept. Agr. Farm. Bull. 1128, 1920, p. 30.—BLANCHARD, Physis, vol. 5, no. 20, 1922, p. 207.—PATCH, Conn. State Geol. and Nat. Hist. Surv. Bull. no. 34, 1923, p. 301.

The synonymy of this species is somewhat involved but is explained as follows:

*Aphis ribis Linnaeus*, based on Linnaeus's description in Fauna Sueca refers to Réaumur (vol. 3, pl. 22, figs. 7–10) incorrectly, as the plant there shown is mountain maple and not *Ribis*. It should refer to plate 24, figure 4, which is a gooseberry leaf with characteristic pseudogalls. This, then, is *Myzus ribis* (Linnaeus).

*Aphis lactucae* Linnaeus cites only Réaumur (pl. 22 figs. 3–5). Réaumur described two forms, a green and a bronze one, which are evidently a *Macrosiphum*, being, as Réaumur says, like the rose species. Müller in his translation of Linnaeus, 1774, also indicates a *Macrosiphum*. Müller also says that Linnaeus considers Réaumur's lettuce as cultivated lettuce, whereas Réaumur had in mind wild lettuce. Kaltenbach refers to this also. This is immaterial, however, since both the *Macrosiphum* and the *Amphorophora* live on both wild and cultivated lettuce.

*Aphis lactucae* Kaltenbach is based on Kaltenbach's description, but he also cites Réaumur (pl. 22, figs. 3–5), as did Linnaeus. Since Linnaeus' species is different from Kaltenbach's and since Linnaeus based his species entirely on Réaumur, Kaltenbach erred in citing Réaumur. He should also have used another name, since *lactucæ* was preoccupied by Linnaeus.

Most of the older writers cite Réaumur and Linnaeus and give no descriptions of their own. Walker seems to have confused the

*Amphorophora* and the *Macrosiphum* as Passerini and Sanderson have pointed out. He described two or more species with both swollen and slender cornicles as varieties, calling the species *Aphis lactucae* Linnaeus and cited both Linnaeus and Kaltenbach.

Koch under the name of *Rhopalosiphum ribis* Linnaeus seems to confuse two species on *Ribis,* describing and figuring one with swollen cornicles and also speaking of the pseudogalls of *Myzus ribis* Linnaeus.

Buckton follows Koch in calling the winter form *Rhopalosiphum ribis* Linnaeus but figures the typical pseudogalls of *Myzus ribis* Linnaeus. He calls the summer form *Rhopalosiphum lactucae* Kaltenbach.

Van der Goot refers the species to *Rhopalosiphum ribis* Linnaeus. Both he and Buckton also have *Myzus ribis* Linnaeus.

Three names have then been applied to this species—*ribis* Linnaeus, *lactucae* Linnaeus, and *lactucae* Kaltenbach. *Aphis ribis* Linnaeus is accepted to be *Myzus ribis* Linnaeus. *Aphis lactucae* Linnaeus is a *Macrosiphum. Aphis lactucae* Kaltenbach is a homonym of *Aphis lactucae* Linnaeus, and can not be used. A new name is therefore necessary and the name *cosmopolitana* is here proposed.

This species seems to have very close relatives, both on currant and on its summer hosts. On currant I am describing in this paper *pergandei,* new species. On *Sonchus* there are several forms as discussed on page 4.

*Apterous spring form on Ribes.*—Antennae shorter than body, light colored, not conspicuously imbricated, hairs inconspicuous, much shorter than width of segment, III with 1–3 small sensoria at base. Antennal tubercles of moderate size. Beak reaching between second and third coxae. Cornicles short, thick, plainly swollen, the tips darker and imbricated. The cauda narrow, strongly constricted in some specimens, less so in others, three sets of lateral hairs.

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0.576 | ? | 0.280 | 0.240 | 0.096+0.320 |
| | 0.560 | 3 | 0.320 | 0.256 | 0.096+0.320 |
| 2 | 0.544 | 1 | 0.224 | 0.240 | ? |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0.464 | 0.304 | 0.592 | 0.128 | 0.040 | 0.048 |
| 2 | 0.448 | 0.224 | 0.448 | 0.096 | 0.040 | 0.048 |
| | | | 0.512 | 0.088 | 0.040 | 0.048 |

*Spring Migrant on Ribes.*—Antennae dark colored, somewhat longer than body, tuberculate, hairs inconspicuous, shorter than width of segment, I gibbous on inner side. Antennal tubercles very small. Beak short, not reaching second coxae. Prothoracic tubercles showing. Abdominal segments with lateral dark patches. Cornicles rather short, moderately swollen, slightly imbricated at tips. Cauda long, strongly constricted, with three sets of lateral hairs.

*Antennal measurements*

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1----- | 0. 688 | 46 | 0. 392 | 15 | 0. 336 | 6 | 0. 112+0. 848 |
| | 0. 720 | 50 | 0. 392 | 18 | 0. 320 | 5 | 0. 112+0. 832 |
| 2----- | 0. 640 | 42 | 0. 400 | 17 | 0. 288 | 6 | 0. 128+ ? |
| | 0. 696 | 40 | 0. 384 | 15 | 0. 344 | 7 | 0. 128+0. 784 |
| 3----- | 0. 736 | 42 | 0. 392 | 17 | 0. 336 | 6 | 0. 112+0. 736 |
| | 0. 704 | 46 | 0. 400 | 17 | 0. 320 | 5 | 0. 104+0. 768 |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1--------- | 0. 464 | 0. 272 | 0. 416 | 0. 088 | 0. 040 | 0. 048 |
| | | | 0. 416 | 0. 088 | 0. 040 | 0. 048 |
| 2--------- | 0. 448 | 0. 240 | 0. 448 | 0. 088 | 0. 040 | 0. 056 |
| 3--------- | 0. 464 | 0. 248 | 0. 416 | 0. 088 | 0. 040 | 0. 056 |
| | | | 0. 416 | 0 088 | 0. 040 | 0. 056 |

*Alate viviparous female* (*on Sonchus*).—Antennae about one-quarter longer than body, dark colored, imbricated, numerous sensoria, hairs shorter than width of segment, somewhat capitate. Antennal tubercles very small. Prothoracic lateral tubercles present, a hair in front of each. Abdominal segments with lateral dark spots, each spot imbricated and having several hairs and usually a tubercle. The spiracle shows either on or near this dark spot. A large dorsal dark area above and between base of cornicles. Cornicles short, distinctly swollen, the tip with about two imbrications. Cauda long, slender, strongly constricted, the lateral edges above constriction showing as dark colored. An occasional specimen has the cauda much broader and not strongly constricted. Three sets of lateral hairs on cauda.

*Antennal measurements*

| No. | Locality | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|---|
| 1 | D. C | 0. 640 | 37 | 0. 352 | 13 | 0. 304 | 3 | 0. 120+0. 720 |
| | | 0. 608 | 38 | 0. 336 | 9 | 0. 304 | 1 | ? |
| 2 | ? | 0. 800 | 47 | 0. 480 | 15 | 0. 384 | 5 | 0. 112+0. 880 |
| | | 0. 800 | 42 | 0. 464 | 13 | 0. 384 | 5 | 0. 096+0. 848 |
| 3 | La | 0. 656 | 42 | 0. 368 | 9 | 0. 320 | 3 | 0. 096+ ? |
| 4 | D. C | 0. 656 | 33 | 0. 432 | 15 | 0. 320 | 3 | 0. 080+ ? |
| 5 | D. C | 0. 704 | 44 | 0. 448 | 14 | 0. 288 | 1 | 0. 096+0. 752 |
| | | 0. 656 | 43 | 0. 416 | 12 | 0. 352 | 1 | 0. 112+0. 576 |
| 6 | D. C | 0. 784 | 45 | 0. 448 | 17 | 0. 368 | 4 | 0. 112+0. 848 |
| | | 0. 784 | 49 | 0. 448 | 19 | 0. 336 | 6 | 0. 112+0. 848 |
| 7 | D. C | 0. 816 | 53 | 0. 480 | 18 | 0. 400 | 1 | 0. 112+0. 944 |
| | | 0. 768 | 54 | 0. 496 | 16 | 0. 368 | 7 | 0. 112+0. 928 |
| 8 | D. C | 0. 672 | 40 | 0. 368 | 13 | 0. 304 | 3 | 0. 096+ ? |
| | | 0. 672 | 42 | 0. 352 | 12 | 0. 280 | 2 | 0. 096+ ? |
| 9 | D. C | 0. 672 | 39 | 0. 400 | 10 | 0. 320 | 6 | 0. 112+0. 880 |
| | | 0. 688 | 42 | 0. 392 | 14 | 0. 368 | 7 | 0. 128+0. 880 |
| 10 | D. C | 0. 640 | 44 | 0. 336 | 13 | 0. 320 | 1 | 0. 112+0. 816 |
| | | 0. 592 | 45 | 0. 352 | 11 | 0. 320 | 3 | 0. 112+0. 832 |
| 11 | Ill | 0. 768 | 26 | 0. 528 | 18 | 0. 400 | 3 | 0. 144+0. 832 |
| | | 0. 768 | 47 | 0. 528 | 15 | 0. 416 | 3 | 0. 144+0. 912 |
| 12 | D. C | 0. 688 | 41 | 0. 400 | 16 | 0. 224 | 1 | 0. 096+0. 640 |
| | | 0. 688 | 46 | 0. 384 | 15 | 0. 288 | 6 | 0. 096+ ? |
| 13 | D. C | 0. 896 | 57 | 0. 488 | 17 | 0. 432 | 4 | 0. 144+1. 024 |
| | | 0. 880 | 56 | 0. 512 | 18 | 0. 400 | 1 | 0. 128+1. 072 |
| 14 | D. C | 0. 640 | 44 | 0. 368 | 12 | 0. 320 | 6 | 0. 112+0. 752 |
| | | 0. 624 | 47 | 0. 352 | 10 | 0. 336 | 5 | 0. 128+0. 752 |
| 15 | D. C | 0. 736 | 48 | 0. 432 | 16 | 0. 352 | 3 | 0. 112+0. 992 |
| | | 0. 752 | 49 | 0. 432 | 15 | 0. 336 | 6 | 0. 112+0. 896 |
| 16 | ? | 0. 592 | 34 | 0. 352 | 13 | 0. 288 | 3 | 0. 112+0. 768 |
| | | 0. 640 | 34 | 0. 384 | 13 | 0. 240 | 4 | 0. 104+0. 800 |
| 17 | Porto Rico | 0. 736 | 46 | 0. 432 | 12 | 0. 352 | 3 | 0. 112+0. 864 |
| | | 0. 704 | 41 | 0. 416 | 11 | 0. 368 | 3 | 0. 112+0. 880 |
| 18 | La | 0. 752 | 42 | 0. 432 | 13 | 0. 336 | 3 | 0. 112+0. 832 |
| | | 0. 784 | 43 | 0. 416 | 11 | 0. 368 | 4 | 0. 112+0. 864 |
| 19 | Calif | 0. 672 | 43 | 0. 352 | 10 | 0. 320 | 1 | 0. 112+0. 720 |
| | | 0. 640 | 38 | 0. 384 | 9 | 0. 336 | 1 | 0. 128+0. 752 |
| 20 | Calif | 0. 800 | 46 | 0. 448 | 14 | 0. 384 | 2 | 0. 128+0. 864 |
| | | 0. 800 | 47 | 0. 464 | 11 | 0. 368 | ----- | 0. 112+0. 832 |
| 21 | Calif | 0. 672 | 40 | 0. 448 | 14 | 0. 304 | 3 | 0. 112+0. 592 |
| | | 0. 704 | 46 | 0. 424 | 16 | 0. 312 | 4 | 0. 112+0. 528 |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 432 | 0. 208 | 0. 400 | 0. 064 | 0. 040 | 0. 048 |
| 2 | 0. 464 | 0. 256 | 0. 448 | 0. 080 | 0. 040 | 0. 048 |
| 3 | 0. 480 | ? | ? | ? | ? | ? |
| 4 | 0. 480 | 0. 224 | 0. 480 | 0. 112 | 0. 040 | 0. 048 |
| 5 | 0. 480 | 0. 192+ | 0. 480 | 0. 096 | 0. 040 | 0. 056 |
| 6 | 0. 480 | 0. 240 | 0. 448 | 0. 096 | 0. 040 | ? |
| 7 | 0. 496 | 0. 256 | 0. 496 | 0. 088 | 0. 040 | 0. 056 |
| 8 | 0. 448 | 0. 224 | 0. 384 | 0. 080 | 0. 040 | 0. 048 |
| 9 | 0. 464 | 0. 224 | 0. 400 | 0. 080 | 0. 040 | 0. 048 |
| 10 | 0. 432 | 0. 176 | 0. 368 | 0. 072 | 0. 040 | 0. 056 |
| 11 | 0. 480 | 0. 272 | 0. 512 | 0. 096 | 0. 048 | 0. 056 |
| 12 | 0. 448 | 0. 240+ | 0. 416 | 0. 064 | 0. 032 | 0. 048 |
| 13 | 0. 496 | 0. 224 | 0. 480 | 0. 088 | 0. 056 | 0. 040 |
| 14 | 0. 448 | 0. 224 | 0. 400 | 0. 080 | 0. 040 | 0. 048 |
| 15 | 0. 456 | 0. 224 | 0. 480 | 0. 072 | 0. 040 | 0. 048 |
| 16 | 0. 440 | 0. 224 | 0. 352 | 0. 064 | 0. 032 | 0. 048 |
| 17 | 0. 464 | 0. 240 | 0 416 | 0. 080 | 0. 040 | 0. 048 |
| 18 | 0. 432 | 0. 272 | 0. 448 | 0. 080 | 0. 040 | 0. 048 |
| 19 | 0. 456 | 0. 240 | 0. 432 | 0. 088 | 0. 040 | 0. 056 |
| 20 | 0. 464 | 0. 320 | 0. 464 | 0. 080 | 0. 040 | 0. 048 |
| 21 | 0. 480 | 0. 272 | 0. 448 | 0. 096 | 0. 048 | 0. 056 |

*Color notes* (*Pergande MSS.*).—"October 30, 1899, the winged form is pale yellowish green, with the head, antennae, thoracic lobes, lateral spot in front of anterior wings, sternal plate, lateral spots in front of nectaries, apex of femora and tibiae and tarsi black; a broad dusky band across prothorax; a dusky band about the middle of the abdomen, the more or less confluent bands in front of nectaries, or all three may be joined laterally, forming an angulated edge; the last band is joined posteriorly by two, posteriorly diverging, stout branches between the nectaries; no bands behind them, though there are two dusky lateral spots behind the nectaries, the anterior one much the largest. Legs, nectaries and tail yellow, the apex of the nectaries dusky. Stigma very pale dusky, subcosta yellowish, veins blackish. November 10, 1899, found again a number of apterous and one winged female, the latter being considerably larger than those found October 30, with the spots on the abdomen larger and deep black, though structurally they are all alike. Found also two migrants, larvae and pupa on *Lactuca canadensis*. The migrants are smaller than the one on *Sonchus* though otherwise alike."

*Apterous viviparous female* (*Summer Form on Sonchus*).—Antennae about equaling length of body, hairs small, heavy, III with a row of 5 to 20 sensoria, distal segments imbricated, I and II gibbous on inner side. Antennal tubercles fairly large and prominent. Beak reaching slightly beyond second coxae. No dark patches or tubercles showing as in alates. Cornicles short, plainly swollen, with about two imbrications at tip. Cauda long, strongly constricted, three sets of lateral hairs. Measurements as follows:

*Antennal measurements*

| No. | Locality | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|---|
| 1 | D. C. | 0. 592 | 11 | 0. 336 | 0. 288 | 0. 096+0. 592 |
| | | 0. 592 | 9 | 0. 336 | 0. 304 | 0. 096+ ? |
| 2 | ? | 0. 736 | 13 | 0. 432 | 0. 352 | 0. 096+0. 688 |
| | | 0. 720 | 15 | 0. 432 | 0. 352 | 0. 112+0. 784 |
| 3 | D. C. | 0. 656 | 8 | 0. 368 | 0. 288 | 0. 112+0. 560 |
| | | 0. 672 | 5 | 0. 384 | 0. 304 | 0. 112+0. 576 |
| 4 | D. C. | 0. 624 | 8 | 0. 384 | 0. 304 | 0. 096+0. 784 |
| | | 0. 592 | 9 | 0. 368 | 0. 320 | 0. 096+0. 704 |
| 5 | D. C. | 0. 720 | 11 | 0. 480 | 0. 368 | 0. 128+0. 832 |
| | | 0. 736 | 9 | 0. 464 | 0. 320 | 0. 112+0. 800 |
| 6 | D. C. | 0. 640 | 11 | 0. 368 | 0. 288 | 0. 096+0. 784 |
| | | 0. 624 | 10 | 0. 368 | 0. 304 | 0. 112+0. 816 |
| 7 | D. C. | 0. 640 | 6 | 0. 352 | 0. 288 | 0. 080+0. 608 |
| 8 | Ill. | 0. 624 | 9 | 0. 368 | 0. 336 | 0. 112+ ? |
| | | 0. 656 | 13 | 0. 416 | 0. 336 | 0. 112+0. 496 |
| 9 | D. C. | 0. 672 | 9 | 0. 400 | 0. 336 | 0. 128+ ? |
| | | 0. 704 | 9 | 0. 416 | 0. 368 | 0. 128+0. 800 |
| 10 | D. C. | 0. 624 | 7 | 0. 352 | 0. 336 | 0. 112+0. 736 |
| 11 | D. C. | 0. 640 | 11 | 0. 416 | 0. 304 | 0. 112+0. 816 |
| | [illegible] | 0. 640 | 9 | 0. 400 | 0. 336 | 0. 112+0. 816 |
| 12 | La. | 0. 720 | 11 | 0. 384 | 0. 240 | 0. 064+0. 592 |
| | | 0. 688 | 15 | 0. 400 | 0. 320 | 0. 080+0. 640 |
| 13 | D. C. | 0. 672 | 16 | 0. 416 | 0. 320 | 0. 096+0. 816 |
| | | 0. 672 | 13 | 0. 432 | 0. 320 | 0. 112+0. 848 |
| 14 | ? | 0. 576 | 4 | 0. 336 | 0. 288 | 0. 096+0. 720 |
| | | 0. 576 | 4 | 0. 336 | 0. 288 | 0. 112+0. 704 |
| 15 | ? | 0. 672 | 16 | 0. 416 | 0. 352 | 0. 112+0. 720 |
| | | 0. 672 | 15 | 0. 416 | 0. 320 | 0. 112+ ? |
| 16 | Calif. | ? | ? | ? | ? | ? |
| 17 | France | 0. 800 | 16 | 0. 496 | 0. 416 | 0. 144+0. 768 |
| | | 0. 848 | 19 | 0. 528 | 0. 432 | 0. 128+0. 832 |
| 18 | Calif. | 0. 592 | 8 | 0. 336 | 0. 272 | 0. 112+ ? |
| 19 | Belgium | 0. 640 | 21 | 0. 432 | 0. 352 | 0. 112+0. 688 |
| 20 | Belgium | 0. 672 | 14 | 0. 368 | 0. 336 | 0. 112+ ? |
| | | 0. 656 | 14 | 0. 384 | 0. 336 | 0. 102+ ? |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 448 | 0. 272 | 0. 448 | 0. 080 | 0. 04 | 0. 048 |
| 2 | 0. 480 | ? | 0. 512 | 0. 096 | 0. 04 | 0. 056 |
| 3 | 0. 464 | 0. 304 | 0. 496 | 0. 096 | 0. 04 | 0. 056 |
| 4 | 0. 480 | ? | 0. 480 | 0. 080 | 0. 04 | 0. 048 |
| 5 | 0. 496 | 0. 240 | 0. 512 | 0. 096 | 0. 04 | 0. 048 |
| 6 | 0. 448 | 0. 240 | 0. 480 | 0. 080 | 0. 04 | 0. 048 |
| 7 | 0. 416 | ? | 0. 480 | 0. 088 | 0. 04 | 0. 048 |
| 8 | 0. 496 | 0. 288 | 0. 544 | 0. 096 | 0. 04 | 0. 048 |
| 9 | 0. 304 | 0. 304 | 0. 560 | 0. 096 | 0. 04 | 0. 048 |
| 10 | 0. 432 | 0. 272 | 0. 448 | 0. 080 | 0. 04 | 0. 048 |
| 11 | 0. 448 | 0. 288 | 0. 512 | 0. 072 | 0. 04 | 0. 048 |
| 12 | 0. 480 | 0. 288 | 0. 496 | 0. 088 | 0. 04 | 0. 048 |
| 13 | 0. 464 | 0. 288 | 0. 496 | 0. 080 | 0. 04 | 0. 048 |
| 14 | 0. 448 | 0. 224 | 0. 416 | 0. 064 | 0. 04 | 0. 048 |
| 15 | 0. 504 | 0. 240 | 0. 560 | 0. 096 | 0. 04 | 0. 048 |
| 16 | 0. 480 | 0. 288 | 0. 496 | 0. 088 | 0. 04 | 0. 048 |
| 17 | 0. 512 | 0. 320 | 0. 640 | 0. 102 | 0. 048 | 0. 056 |
| 18 | 0. 480 | 0. 272 | 0. 416 | 0. 088 | 0. 04 | 0. 048 |
| 19 | 0. 488 | 0. 320 | 0. 496 | 0. 088 | 0. 04 | 0. 048 |
| 20 | 0. 480 | ? | 0. 448 | 0. 088 | 0. 04 | 0. 048 |

*Color notes (Pergande MSS.)*.—"Apterous females, larvae and pupae very pale yellowish green, pale bluish green or almost white with but a slight yellowish or greenish tinge; the head is generally palest, frequently white; all are covered with a delicate pruinose secretion; antennae and legs white or faintly brownish, tip of tibiae and tarsi darkest, tip of tarsi and claws blackish; apex of antennal joints 3 to 5, the basal section and apical one-third or more of the spur of the sixth black. Eyes brown; nectaries and tail of color of legs. The thorax and wing pads of the pupa are almost white with the external edge of the wing pads blackish."

*Fall migrant (On Ribes)*.—Antennae longer than body; dark colored, III, IV, and V with sensoria, tuberculate, distal segments imbricated; hairs shorter than width of segment, I gibbous on inner side. Antennal tubercles very small, especially on outer side. Beak short, hardly reaching second coxae. Prothoracic lateral tubercles distinct, a spine showing in front of each. Abdominal segments with large lateral dark areas, each bearing a tubercle and one or more spines. Cornicles comparatively short, conspicuously swollen, slightly imbricated at tip. Cauda long, strongly constricted, three sets of lateral hairs. Measurements as follows:

*Antennal measurements*

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1----- | 0. 768 | 45 | 0. 480 | 12 | 0. 400 | 3 | 0. 144+0. 656 |
| | 0. 776 | 44 | 0. 472 | 11 | 0. 400 | 3 | 0. 128+ ? |
| 2----- | 0. 768 | 42 | 0. 464 | 15 | 0. 384 | 2 | 0. 144+0. 848 |
| | 0. 800 | 44 | 0. 432 | 12 | 0. 356 | 0 | 0. 112+0. 816 |
| 3----- | 0. 752 | 51 | 0. 464 | 15 | 0. 352 | 3 | 0. 128+0. 704 |
| | 0. 800 | 51 | 0. 464 | 13 | 0. 352 | 4 | 0. 112+0. 800 |
| 4----- | 0. 800 | 45 | 0. 512 | 19 | 0. 432 | 6 | 0. 128+1. 216 |
| | 0. 800 | 47 | 0. 512 | 16 | 0. 416 | 6 | 0. 112+1. 152 |
| 5----- | 0. 736 | 46 | 0. 448 | 19 | 0. 384 | 8 | 0. 128+0. 864 |
| | 0. 736 | 43 | 0. 432 | 16 | 0. 368 | 7 | 0. 128+0. 848 |

*Other measurements*

| No. | Head | Cauda | Cornicles | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Narrow X | Flange |
| 1----- | 0. 480 | 0. 272 | 0. 464 | 0. 088 | 0. 048 | 0. 056 |
| | | | 0. 464 | 0. 096 | 0. 040 | 0. 048 |
| 2----- | 0. 480 | 0. 208 | 0. 432 | 0. 088 | 0. 040 | 0. 056 |
| | | | 0. 448 | 0. 088 | 0. 040 | 0. 056 |
| 3----- | 0. 488 | ? | 0. 416 | 0. 080 | 0. 040 | 0. 048 |
| | | | 0. 400 | 0. 088 | 0. 040 | 0. 048 |
| 4----- | 0. 520 | 0. 208 | 0. 400 | 0. 072 | 0. 040 | 0. 056 |
| | | | 0. 400 | 0. 088 | 0. 040 | 0. 056 |
| 5----- | 0. 480 | 0. 208 | ? | ? | ? | ? |

Pergande left the following color notes: "The winged form is either yellowish or yellowish green. Head, antennae, band across prothorax, thoracic lobes and sternal plate, apex of femora, tibiae and tarsi, lateral spot in front of wings, 3 lateral spots in front of nectaries black; the lateral edge of this spot is more or less sharply 3-dentate; the anterior angle is formed of two very fine black and curved lines, uniting at the ends in a large black spot; the other two angles are formed of 3 broad, and shorter black bands, with the last band sometimes very fine and barely visible except at the angle; the space between these lines and bands is of the color of the abdomen, though sometimes they may be confluent so as to form a complete black spot; nectaries pale dusky, tail yellow; subcosta yellowish, the stigma pale dusky."

I have received a single alate specimen from Dr. J. T. Potgieter taken on sycamore at Columbus, Ohio, October 6, 1922. I can see no specific difference between it and the form described above from currant. It is probable that it was simply resting on the sycamore.

*Alate male*.—Antennae longer than body, dark colored, imbricated, III, IV, and V with numerous tuberculate sensoria; hairs shorter than width of segments. Antennal tubercles very small. Beak short, about reaching second coxae. A small lateral prothoracic tubercle with spine in front of it. Abdominal segments with a dark area and several smaller ones on dorsum of abdomen. Cornicles short, strongly swollen, slightly imbricated at tip. Cauda short, broad, conical, not constricted, with 3 sets of lateral hairs. Measurements as follows:

*Antennal measurements*

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 9155 | 0.736 | 44 | 0.480 | 18 | 0.392 | 8 | 0.128+1.104 |
| | 0.816 | 39 | ? | ? | ? | ? | 0.128+1.248 |
| 5591 | 0.800 | 57 | 0.504 | 19 | 0.448 | ? | ? |
| 3/2 | 0.912 | 55 | 0.432 | 11 | 0.464 | 8 | 0.144+ ? |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 9155 | 0.472 | 0.144 | 0.384 | 0.08 | 0.04 | 0.048 |
| | | | 0.384 | 0.08 | 0.04 | 0.048 |
| 5591 | 0.512 | 0.144 | 0.416 | 0.08 | 0.04 | 0.048 |
| 3/2 | | | 0.416 | 0.08 | 0.04 | 0.048 |

No. 9155, described above, was taken on *Sonchus asper* January 24, 1900, District of Columbia. No. 5591, 3/2, was taken at Fairbury, Ill., on *Sonchus oleracea* on October 15, 1894, along with alate viviparous females.

*Apterous oviparous female.*—Antennae about the same length as the body; on some specimens a little longer than body, light colored, faintly imbricated, III with a row of 2–9 sensoria. Antennal tubercles prominent. Beak reaching beyond second coxae. No thoracic or abdominal tubercles showing. Hind tibiae with numerous sensoria, especially on basal three-fourths. Cornicles plainly swollen; about two imbrications at tip. Cauda short, plainly constricted, three sets of lateral hairs. Measurements as follows:

*Antennal measurements*

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0.384 | 6 | 0.304 | 0.256 | 0.112+0.640 |
| | 0.432 | 5 | 0.288 | 0.272 | 0.112+0.656 |
| 2 | 0.384 | 4 | 0.256 | 0.192 | ? |
| | 0.432 | 9 | 0.288 | 0.232 | 0.104+0.496 |
| 3 | 0.440 | 8 | 0.272 | 0.240 | 0.112+0.624 |
| | 0.440 | 6 | 0.272 | 0.232 | 0.112+ ? |
| 4 | 0.464 | ? | 0.272 | 0.224 | 0.112+0.480 |
| | 0.464 | 6 | 0.272 | 0.240 | 0.112+0.464 |
| 5 | 0.432 | 4 | 0.288 | 0.240 | 0.112+0.608 |
| | 0.448 | 2 | 0.296 | 0.272 | 0.112+0.640 |
| 6 | 0.400 | 4 | 0.262 | 0.240 | 0.112+ ? |
| | 0.416 | 4 | 0.240 | 0.208 | 0.112+0.560 |
| 7 | 0.408 | 3 | 0.256 | 0.224 | 0.096+0.552 |
| | 0.432 | 4 | 0.272 | 0.240 | 0.096+0.544 |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0.400 | 0.160 | ? | ? | ? | ? |
| 2 | 0.408 | 0.176 | 0.416 | 0.064 | 0.032 | 0.040 |
| | | | 0.400 | 0.064 | 0.032 | 0.040 |
| 3 | 0.376 | 0.144 | 0.352 | 0.056 | 0.040 | 0.048 |
| | | | 0.368 | 0.064 | 0.040 | 0.048 |
| 4 | 0.400 | 0.208 | 0.400 | ? | ? | ? |
| | | | 0.400 | ? | ? | ? |
| 5 | 0.400 | ? | 0.352 | 0.064 | 0.032 | 0.040 |
| | | | 0.384 | 0.064 | 0.032 | 0.040 |
| 6 | 0.360 | 0.144 | 0.352 | 0.064 | 0.040 | 0.040 |
| | | | 0.368 | 0.064 | 0.040 | 0.040 |
| 7 | 0.400 | 0.192 | 0.352 | 0.064 | 0.040 | 0.040 |
| | | | 0.352 | 0.072 | 0.032 | 0.040 |

Pergande left the following notes: "Pale yellow and slightly pruinous. Apex of antennal joints 3–6 and terminal one-half of the spur blackish; apex of tibiae and tarsi dusky, eyes brown. The nectaries are sometimes very pale brownish, also the legs, with extreme tip of nectaries dusky."

*Biology.*—This species alternates between various species of *Ribes* and such plants as *Sonchus*, *Lactuca*, etc.

On *Ribes* it occurs on the leaves, usually on the underside, often causing them to curl and cluster. Sometimes it is associated with *Myzus ribis* (Linnaeus). It is probable that a few individuals remain throughout the year, but most of them have left by the latter part of July.

On the summer hosts it is very numerous on the leaves, stem, and flower heads. It produces two or more generations, remaining on these plants until late autumn, we having records as late as November 24, and on a potted plant of *Sonchus* as late as January 24. In the autumn it returns to *Ribes*, where the eggs are laid. The earliest record we have in this country of the sexual forms is October 21, and females have been found until late in November.

The eggs are laid on the twigs of currant and are shining black in color. Van der Goot found nearly mature oviparous females on *Deutzia crenata*.

Miss Jackson reports it to be attacked by *Empusa* (*Entomophthora*) *aphides* Hoffman and *Empusa* (*Triplosporium*) *fresenii* Nowakowaki. Theobald found it in the crops of young fowls.

*Food plants.*—*Ribes* species, *Sonchus* species, *Lactuca*, *Lampsana vulgaris*, *Viburnum opulus*, *Cichorium endivum*, *Picris hieracioides*, *Taraxicum*, milkweed (Swain), *Deutzia crenata* (Van der Goot).

*Distribution.*—United States, Europe, India, Japan, Argentina, Brazil, and Porto Rico.

*Type.*—Kaltenbach's type of *lactucae* is undoubtedly lost. Specimens which I am considering as typical and which agree with descriptions of other authors are in the United States National Museum.

### AMPHOROPHORA DAVIDSONI, new species

Figs. 27–32, and 139–141

*Amphorophora rubi* (Kaltenbach) SWAIN (not *rubi* Kaltenbach), Univ. Cal. Pub., vol. 3, No. 1, 1919, p. 54.

This species can be separated from closely related ones on *Rubus* by its shorter cornicles which are subequal with III, by its dark antennae, the distal segments of which become lighter, by its long antennal hairs, and by the larger number of sensoria on III, 34–42.

*Alate viviparous female.*—Antennae about equal to the length of the body, III dark, the other segments lighter, hairs very conspicuous, usually longer than the width of the segment, distal segments imbricated, III with 34–42 sensoria, not in a row. Antennal tubercles prominent. No dorsal or lateral tubercles showing on head, thorax, and abdomen. Beak reaching beyond second and nearly to third coxae. Cornicles not very dark, somewhat swollen, distinctly reticulated, the rest of the cornicles imbricated. Cauda light colored, long, conspicuously constricted, three to four sets of lateral hairs. Margin of wing cloudy, but not a distinct dusky spot as in *rubicola* Oestlund. Measurements as follows:

*Antennal measurements*

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 824 | 34 | 0. 464 | 0. 432 | 0. 128+(0. 336+) |
|  | 0. 848 | 36 | 0. 432 | 0. 456 | 0. 128+ 0. 880 |
| 2 | 0. 856 | 42 | 0. 464 | 0. 448 | 0. 128+ 0. 896 |
|  | 0. 832 | ? | 0. 480 | 0. 464 | 0. 128+ ? |
| 3 | 0. 816 | 37 | 0. 480 | 0. 432 | 0. 128+(0. 528+) |
|  | 0. 896 | ? | 0. 480 | 0. 480 | 0. 096+ 0. 880 |

*Other measurements*

| No. | Head | Cauda | Length | Reticulated | Wide X | Small X | Flange |
|---|---|---|---|---|---|---|---|
| 1 | ? | 0. 352 | 0. 880 | 0. 080 | 0. 096 | 0. 056 | 0. 072 |
|  |  |  | 0. 848 | 0. 096 | 0. 096 | 0. 056 | 0. 072 |
| 2 | 0. 496 | 0. 304 | 0. 848 | 0. 080 | 0. 104 | 0. 056 | 0. 072 |
|  |  |  | 0. 848 | 0. 096 | 0. 096 | 0. 056 | 0. 072 |
| 3 | 0. 544 | 0. 336 | 0. 880 | 0. 096 | 0. 120 | 0. 056 | 0. 072 |
|  |  |  | 0. 880 | 0. 080 | 0. 120 | 0. 056 | 0. 080 |

*Alate nymphs (last instar)*

| III | IV | V | VI | Head width | Cornicle |
|---|---|---|---|---|---|
| 0. 512 | 0. 288 | 0. 304 | 0. 112+0. 624 | 0. 456 | 0. 688 |
| 0. 496 | 0. 288 | 0. 288 | 0. 112+0. 608 |  | 0. 624 |
| 0. 528 | 0. 336 | 0. 336 | 0. 112+0. 736 | 0. 544 | 0. 768 |
| 0. 528 | 0. 336 | 0. 352 | 0. 104+0. 640 |  |  |
| 0. 560 | 0. 352 | 0. 336 | 0. 112+0. 720 | 0. 512 | 0. 720 |

*Apterous nymph (last instar)*

| III | IV | V | VI | Head width | Cornicle |
|---|---|---|---|---|---|
| 0. 480 | 0. 288 | 0. 288 | 0. 112+0. 640 | 0. 448 | 0. 640 |
| 0. 480 | 0. 288 | 0. 288 | 0. 096+0. 640 | ? | 0. 640 |

This species was taken by Davidson at San Jose, Calif., July 4, 1911, on thimbleberry. The collection consists of three alate viviparous females, several alate nymphs, and one apterous nymph.

As explained under *rubi* Kaltenbach, I believe the specimens which Swain received from Gillette and which he described as *rubi* Kaltenbach are in reality this new species. There is an alate male and several oviparous females in this collection. The following descriptions and the drawings are made from these slides.

*Alate male.*—Antennae longer than body, dark colored, segment III darker than the other segments, hairs nearly or quite as long as the width of the segment, segments III and V with large subcircular sensoria, the number being shown in the table, segment IV without sensoria. Beak reaching third coxae. Abdomen with lateral tubercles. Cornicles long, moderately but conspicuously swollen, dark colored, imbricated over the entire length, the tip plainly reticulated. Cauda short, not constricted, lighter colored than cornicles, with about three sets of hairs.

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1....... | 0. 720<br>0. 688 | 41<br>48 | 0. 512<br>0. 544 | 0<br>0 | 0. 432<br>0. 432 | 11<br>12 | 0. 128+0. 928<br>0. 128+0. 848 |

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1........ | ? | 0. 128 | 0. 672<br>? | 0. 064<br>0. 064 | 0. 080<br>0. 072 | 0. 048<br>0. 048 | 0. 064<br>0. 064 |

*Oviparous female.*—Antennae longer than body, light colored; tips of segments and base of VI darker, hairs about as long as width of segments, segment III with an uneven row of subcircular sensoria. Antennal tubercles of moderate size. Beak reaching third coxae. Prothoracic lateral tubercles distinct. Hind tibiae with numerous sensoria on basal half, becoming less numerous beyond middle with none on distal portion. Cornicles very long, moderately but plainly swollen, lighter colored than in the male but the tips dark, less imbricated than in male, the tips plainly reticulated. Cauda small, short, broad, not constricted; about three lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1....... | 0. 672<br>0. 720 | 9<br>10 | 0. 480<br>0. 464 | 0. 400<br>0. 384 | 0. 144+0. 688<br>0. 144+0. 656 |
| 2....... | 0. 656<br>0. 688 | 13<br>12 | 0. 416<br>0. 400 | 0. 336<br>0. 400 | 0. 104+0. 640<br>0. 096+0. 576 |
| 3....... | 0. 688<br>0. 704 | 17<br>10 | 0. 448<br>0. 440 | 0. 384<br>0. 400 | 0. 128+0. 672<br>0. 128+0. 640 |
| 4....... | 0. 656<br>0. 624 | 8<br>11 | 0. 464<br>0. 480 | 0. 352<br>0. 368 | 0. 096+0. 592<br>0. 104+0. 640 |

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 464 | 0. 144 | 0. 992 | 0. 080 | 0. 112 | 0. 056 | 0. 072 |
| | | | 0. 976 | 0. 080 | 0. 120 | 0. 064 | 0. 080 |
| 2 | 0. 456 | 0. 208 | 0. 800 | 0. 064 | 0. 112 | 0. 064 | 0. 080 |
| | | | 0. 848 | 0. 064 | 0. 104 | 0. 064 | 0. 072 |
| 3 | 0. 408 | ? | 0. 928 | 0. 064 | 0. 160 | 0. 056 | 0. 072 |
| 4 | 0. 448 | 0. 224 | 0. 960 | 0. 064 | 0. 120 | 0. 064 | 0. 088 |
| | | | 0. 952 | 0. 064 | 0. 120 | 0. 064 | 0. 080 |

*Cotypes.*—Alate viviparous female deposited in the U. S. National Museum, Cat. No. 26375, in the Maine Agricultural Experiment Station and in the collection of Harold Morrison. Paracotype slides of the male and oviparous female, which are a part of the Swain collection, are returned to Stanford University.

### AMPHOROPHORA ESSIGWANAI, new name

Figs. 101–108

*Rhopalosiphum indicum* v. D. GOOT of Essig and Kuwana, Proc. Cal. Acad. Sci., vol. 8, no. 3, 1918, p. 55.

In 1916 Van der Goot described and figured his *Rhopalosiphum indicum* from the apterous form only, taken on an unknown host plant. In 1917 he described the alate form of what he considered to be the same species, taken apparently on the wing. Both of these collections were made in India. In 1918 Essig and Kuwana, not having received the above description of the alate, described the alate form of what they considered to be this species, taken on *Eus caphis japonica* and *Staphylea bumalda* in Japan. The two descriptions apparently do not refer to the same species. Essig kindly loaned me some of his specimens. I also have specimens sent by Takahashi taken in Formosa on an unknown host and determined by him as *indicum* v. d. Goot. They are most certainly different from Essig and Kuwana's specimens, and they agree very well with Van der Goot's description. Van der Goot's description of the alate must be accepted as *indicum* until proven otherwise, and I am referring Takahashi's specimens to this species. A new name must therefore be given to Essig and Kuwana's species and I here propose *essigwanai*. I am removing *indicum* v. d. Goot from the genus *Amphorophora*, where it was placed by Takahashi, as it is not typical.

In 1918 Matsumura described his *Rhopalosiphum miniatum*, which Takahashi says is synonymous with *indicum* v. d. Goot. I have not seen it, but I am accepting Takahashi and am not considering it in connection with the *Amphorophora*.

The following descriptions and the drawings are made from the specimens furnished by Essig.

*Alate viviparous female.*—From one specimen, taken on *Euscaphis japonica* in Japan. Antennae slightly longer than body, rather heavy, dark colored, conspicuously imbricated, hairs very prominent, but shorter than the width of segments, III tuberculate, other segments without secondary sensoria, unguis of VI rather short. Antennal tubercles not prominent. Beak reaching beyond second coxae. Cornicles dark colored, short and heavy in appearance, strongly swollen, plainly reticulated. Cauda small, conical, not constricted, with at least six sets of lateral hairs. Measurements as follows:

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 0. 992 | 53 | 0. 784 | 0. 512 | 0. 144+0. 656 |
| 1. 008 | 54 | 0. 784 | 0. 560 | 0. 144+0. 560 |

| Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0. 704 | 0. 240 | 0. 800 | 0. 144 | 0. 256 | 0. 072 | 0. 096 |
| | | 0. 864 | 0. 144 | 0. 208 | 0. 080 | 0. 104 |

*Apterous viviparous female.*—From one specimen taken on *Staphylea bumalda* in Japan. Antennae longer than the body, imbricated, hairs conspicuous, shorter than width of segments, III with 6–8 small sensoria near base.

| III | IV | V | VI |
|---|---|---|---|
| 1. 216 | 0. 688 | 0. 544 | 0. 192+0. 736 |
| 1. 216 | 0. 672 | 0. 544 | 0. 192+0. 816 |

Head 0.576 mm. across eyes. Antennal tubercles small. Beak reaching nearly to third coxae. Left cornicle not showing. Right cornicle black, 0.768 mm. long, reticulate for 0.08 mm.; widest diameter, 0.144 mm.; smallest diameter, 0.08 mm.; flange, 0.096 mm. Cauda not showing.

*Intermediate.*—One specimen furnished by Essig, taken on *Staphylea bumalda* in Japan. Antennae shorter than body, dark colored (Balsam mount), imbricated, hairs fairly numerous, shorter than width of segment. Segment III with about seven small, round inconspicuous sensoria. Antennal measurements as follows:

| III | IV | V | VI |
|---|---|---|---|
| 1. 248 | 0. 704 | 0. 560 | 0. 176+0. 8 |
| 1. 280 | 0. 720 | 0. 528 | 0. 176+0. 8 |

Head 0.72 mm. across eyes. Antennal tubercles not prominent. Ocelli present but very small. Wings represented only by lobes. Cornicles dark colored, short and not conspicuously swollen, –0.736 mm. long, reticulated for 0.08 mm.; widest diameter, 0.16 mm.; smallest diameter, 0.08 mm.; flange, 0.112 mm.

*Host plants.*—*Euscaphis japonica* and *Staphylea bumalda.*

*Distribution.*—*Japan.*

*Cotypes.*—Deposited in the University of California.

### AMPHOROPHORA EVANSI Theobald

Figs. 85–88

*Amphorophora evansi* THEOBALD, The Entomologists' Monthly Magazine, ser. 3, No. 97, 1923, p. 24.

I have not seen this species. The cornicles seem to be very slender for an *Amphorophora* and the host plant, Austrian pine, is very unusual. When the alate is known, it may prove to belong to another genus.

### AMPHOROPHORA FORMOSANA Takahashi

Figs. 70–71

*Amphorophora formosana* TAKAHASHI, Aphididae of Formosa, pt. 2, Report No. 4, Dept. of Agri., Government Research Institute, Formosa, Japan, 1923, p. 30.

I have not seen this species.

### AMPHOROPHORA HAYHURSTI, new species

Figs. 89–91

*Alate viviparous female.*—Body light colored, head and thorax somewhat darker than abdomen. Antennae somewhat longer than the body, dark colored, very tuberculate, hairs nearly as long as width of segment, heavy but not distinctly capitate. Antennal tubercles prominent. Beak about reaching second coxae. Legs dark, light at base of femora. No thoracic or abdominal tubercles showing. Cornicles short, heavily swollen, dark colored, lighter at base, indistinctly reticulated at tip. Cauda long, narrow, strongly constricted, four sets of lateral hairs. Measurements as follows:

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 1.136 | 125 | 0.608 | 53 | 0.512 | 14 | 0.112+? |
| 1.088 | 122 | 0.592 | 45 | 0.544 | 15 | 0.112+? |

| Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0.552 | 0.4 | 0.624 | 0.032 | 0.144 | 0.056 | 0.064 |
| | | 0.624 | 0.032 | 0.144 | 0.056 | 0.064 |

Described from a single alate viviparous female received by Pergande from Paul Hayhurst (Hayhurst No. 121), collected at Columbia, Missouri, on *Ribis gracile*, with the following note: "On leaves of *Ribis gracile*, very rare; general color green." These were received December 12, 1906. The date of collection is not given.

*Type*.—(Pergande No. 9987). Deposited in U. S. National Museum. Cat. No. 26372.

### AMPHOROPHORA LAINGI, new species

Figs. 112–117, 189

*Rhopalosiphum ampullata* (Buckton) Oestlund, Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, p. 77.—Williams, Univ. Nebr. Spec. Bull. 1, 1891, p. 19.—Hunter, Iowa Agr. Exp. Sta. Bull. 60, 1901, p. 106.—Sanborn, Kans. Univ. Sci. Bull., vol. 3, no. 8, 1906, p. 242.—Van der Goot, Beit. zur Kennt. der Holland. Blattlause, 1915, p. 142.

*Amphorophora ampullata* (Buckton) Williams, Univ. Neb. Studies, vol. 10, no. 2, 1910, p. 72.—Davis, Univ. Neb. Contr. from Dept. Ent. no. 5, 1912, p. 25.—Patch, Maine Agr. Expt. Sta. Bull. 202, 1912, p. 180.—Roberts, Lancashire and Cheshire Naturalist, vol. 10, no. 3, 1917, p. 78.—Jackson, Scottish Naturalist, 1919, p. 158.

*Acyrthosiphon (Amphorophora) ampullatum* Buckton, Fauna de la Russie, 1919, p. 247.

As explained on page 3, this is considered to be a distinct species from *ampullata* Buckton. I take pleasure in naming it after Laing, who first called my attention to the differences. I learn from correspondence with Professor Oestlund that his 1887 description of *ampullata* Buckton is in reality of this new species. Van der Goot's 1915 description is plainly so. I can not tell from William's 1910 description of "*ampullata* Buckt?" what he had, and his specimens seem to be lost, but it was very probably not *ampullata* Buckton, since this is not known from this continent. In view of the rather common and widespread distribution of this species it is very probable that all the references in literature to *ampullata* Buckton, except those which simply catalogue the original description, refer to this species and they are so treated here. I have selected as cotypes certain specimens from Dr. E. M. Patch, of Orono, Me., as this is the only collection I have which has both alate and apterous forms in the same collection.

*Alate viviparous female*.—Antennae one and one-half to two times as long as the body, dark colored, hairs shorter than width of segment, capitate, segment III with 38–51 sensoria, not in a row; other segments with no secondary sensoria. Antennal tubercles very large and prominent. Head with capitate hairs. Beak reaching beyond second coxae. Legs light colored, tips of segments dark. Cornicles long, rather slender, distinctly swollen, basal part light, remainder dark, indistinctly imbricated at tip. Cauda conical, scarcely constricted, concolorous with body, with 7–8 groups of lateral hairs.

*Antennal measurements*

COTYPE SPECIMENS

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 1.280 | 38 | 1.136 | 0.944 | 0.312+ ? |
|  | 1.280 | 40 | 1.152 | 0.912 | 0.288+1.520 |
| 2 | 1.232 | 44 | ? | ? | ? |
|  | 1.264 | 42 | 1.168 | 0.960 | 0.288+1.504 |
| 3 | 1.312 | 54 | 1.184 | 0.960 | 0.304+1.568 |
|  | 1.328 | 51 | 1.152 | 1.008 | 0.336+1.488 |

PARACOTYPE SPECIMEN

|  |  |  |  |  |
|---|---|---|---|---|
| 1.328 | ? | 1.056 | 0.896 | 0.304+1.520 |
| 1.280 | ? | 1.120 | 0.928 | 0.288+1.504 |

*Other measurements*

COTYPE SPECIMENS

| No. | Head | Cauda | Cornicles |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1 | 0.664 | 0.368 | 0.768 | 0.112 | 0.056 | 0.080 |
|  |  |  | 0.768 | 0.112 | 0.056 | 0.080 |
| 2 | 0.656 | 0.400 | 0.688 | 0.112 | 0.056 | 0.088 |
|  |  |  | 0.720 | 0.120 | 0.056 | 0.080 |
| 3 | 0.720 | 0.432 | 0.832 | 0.120 | 0.064 | 0.088 |
|  |  |  | 0.768 | 0.120 | 0.064 | 0.088 |

PARACOTYPE SPECIMEN

| No. | Head | Cauda | Length | Wide X | Small X | Flange |
|---|---|---|---|---|---|---|
| 1 | 0.672 | 0.336 | 0.720 | 0.120 | 0.056 | 0.08 |
|  |  |  | 0.720 | 0.112 | 0.056 | ? |

*Apterous viviparous female.*—Antennae about one and one-half times as long as body, light colored, distal segments imbricated, III with 7–20 sensoria, all on basal half, not in a straight row. Antennal hairs shorter than width of segment; heavy, not pointed. Antennal tubercles unusually large. Hairs on front of head capitate. Beak reaching second coxae, often nearly to third. Cornicles light colored, rather slender, conspicuously swollen, somewhat imbricated at tip. Cauda long, broad, conical, not constricted, with 5–6 groups of lateral hairs.

### *Antennal measurements*

COTYPE SPECIMENS

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1------ | 1. 296 | 10 | 1. 088 | 0. 960 | 0. 320+1. 648 |
|  | 1. 280 | 11 | 1. 120 | 0. 864 | 0. 300+1. 616 |
| 2------ | 1. 312 | 7 | 1. 008 | ? | ? |
|  | 1 280 | 10 | 1. 040 | 0. 880 | ? |
| 3------ | 1. 344 | 18 | 1. 104 | 0. 800 | 0. 272+1. 520 |
|  | 1. 328 | 11 | 1. 072 | 0. 848 | 0. 256+1. 552 |
| 4------ | 1. 088 | 10 | 0. 976 | 0. 752 | 0. 256+1. 568 |
|  | 1. 152 | 12 | 0. 960 | 0. 768 | 0. 272+1. 504 |
| PARACOTYPE SPECIMENS |  |  |  |  |  |
| 5------ | 1. 280 | 14 | 1. 072 | 0. 912 | 0. 320+ ? |
|  | 1. 280 | 16 | 1. 104 | 0. 880 | 0. 320+ ? |
| 6------ | 1. 200 | 14 | 0. 880 | ? | ? |
|  | 1. 216 | 20 | 0. 880 | ? | ? |
|  | 1. 488 | 12 | 1. 104 | 0. 864 | 0. 240+1. 264 |
|  | 1. 424 | 14 | 1. 152 | 0. 928 | 0. 228+(1. 28+) |
|  | 1. 296 | 10 | ? | ? | ? |
|  | 1. 504 | 14 | ? | ? | ? |
|  | 1. 408 | 15 | 0. 976 | 0. 912 | 0. 312+1. 600 |
|  | 1. 440 | 15 | 1. 056 | 0. 832 | ? |

### *Other measurements*

COTYPE SPECIMENS

| No. | Head | Cauda | Cornicles |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1----- | 0. 704 | 0. 400 | 0. 816 | 0. 128 | 0. 056 | 0. 080 |
|  |  |  | 0. 816 | 0. 128 | 0. 056 | 0. 080 |
| 2----- | 0. 728 | 0. 392 | 0. 800 | 0. 128 | 0. 056 | 0. 080 |
|  |  |  | 0. 800 | 1. 128 | 0. 056 | 0. 080 |
| 3----- | 0. 736 | 0. 432 | 0. 880 | 1. 128 | 0. 056 | 0. 088 |
|  |  |  | 0. 864 | 1. 128 | 0. 064 | 0. 096 |
| 4----- | 0. 688 | 0. 352 | 0. 800 | 0. 120 | 0. 056 | 0. 080 |
|  |  |  | 0. 800 | 0. 112 | 0. 056 | 0. 080 |
| PARACOTYPE SPECIMENS |  |  |  |  |  |  |
| 5----- | ? | 0. 320 | 0. 752 | 0. 112 | 0. 056 | 0. 072 |
|  |  |  | 0. 752 | 0. 104 | 0. 072 | 0. 088 |
| 6----- | 0. 736 | 0. 304 | 0. 720 | 0. 112 | 0. 064 | 0. 088 |
|  | 0. 736 | 0. 400 | 0. 856 | 0. 128 | 0. 064 | 0. 088 |
|  |  |  | 0. 832 | 0. 128 | 0. 064 | 0. 088 |
|  | 0. 736 | ? | 0. 848 | 0. 152 | 0. 064 | 0. 088 |
|  |  |  | 0. 848 | 0. 160 | 0. 072 | 0. 096 |
|  | 0. 736 | 0. 352 | 0. 800 | 0. 152 | 0. 072 | 0. 096 |
|  |  |  | 0. 800 | 0. 144 | 0. 064 | 0. 096 |
|  | 0. 704 | 0. 416 | 0. 768 | 0. 136 | 0. 064 | 0. 088 |
|  |  |  | 0. 800 | 0. 136 | 0. 064 | 0. 088 |
|  | 0. 712 | 0. 432 | 0. 800 | 0. 136 | 0. 064 | 0. 088 |
|  |  |  | 0. 800 | 0. 128 | 0. 056 | 0. 088 |
|  | 0. 656 | 0. 400 | 0. 736 | 0. 120 | 0. 064 | 0. 088 |
|  |  |  | 0. 752 | 0. 112 | 0. 056 | 0. 080 |

Van der Goot describes the oviparous female and the male.

Described from three alate viviparous females and four apterous viviparous females taken by Dr. Edith M. Patch on *Onoclea sensibilis* at Orono, Me., July 21, 1922 (Maine No. 172–22). Paracotype specimens were taken by T. L. Guyton at Inglenook, Pa., July 1, 1920 (Guyton number 20–58), by Hayhurst at Sheridan, N. Y. (Hayhurst No. 209, Pergande No. 9986), and were received from Takahashi (Q No. 22018).

*Host plants.*—*Onoclea sensibilis, O. struthiopteris, Polystichum* species, *Asplenium* species.

*Distribution.*—United States (Maine, New York, Pennsylvania, Minnesota), England, Holland, Russia, Japan.

*Cotypes*—Returned to Maine Agricultural Experiment Station. Paracotypes deposited in U. S. National Museum. Cat. No. 26373.

### AMPHOROPHORA MAXIMA, new species

Figs. 174–176

This is one of the largest species of *Amphorophora* I have seen. We have only a single alate specimen and several nymphs. Like *rubicola* Oestlund the cornicle is conspicuously longer than segment III, but it can be distinguished from *rubicola* by its light-colored antennae and by the smaller number of sensoria on III, about 13–17. The wings are torn, so that I am unable to determine whether or not it has a dusky spot.

*Alate viviparous female.*—Antennae longer than the body, light colored, ends of segments and VI darker, hairs about as long as width of segment, III with 13–17 sensoria on outer side; other segments inbricated; length of segments as follows:

| III | IV | V | VI |
|---|---|---|---|
| 0. 848<br>0. 868 | 0. 656<br>0. 656 | 0. 560<br>0. 448+ | 0. 160+0. 824<br>? |

Antennal tubercles prominent. Head 0.608 mm. across eyes. Beak reaching third coxae. No dorsal tubercles showing on head or prothorax. Lateral tubercles present on prothorax and abdomen. Cornicles dark colored, 1.056–1.072 mm. long, distinctly reticulated for 0.08–0.144 mm., the remainder conspicuously imbricated; widest diameter, 0.112–0.064 mm.; flange, 0.08 mm. Cauda light colored, 0.32 mm. long, rather broad, distinctly constricted, tip somewhat upturned.

Described from one specimen taken on salmon-berry in California in 1911. The slide, which bears a number of very young nymphs has the Pergande number 124121. Pergande's notes under this number give no additional data, except that they were received in August.

*Cotypes.*—Deposited in U. S. National Museum. Cat. No. 26378.

### AMPHOROPHORA MINIMA, new species

Figs. 177, 178

A single specimen (Maine No. 67-05) was received from Dr. Edith M. Patch, taken on the wing. It is included in this genus with hesitation.

*Alate viviparous female.*—Very small. Antennae about one and one-half times as long as body; numerous sensoria, but not tuberculate; plainly imbricated; hairs very short and inconspicuous. The head is twisted, but the antennal tubercles appear to be large and distinct. Beak short. No prothoracic or abdominal tubercles showing. Small dark-colored areas at lateral margins of abdominal segments. Cornicle very light colored, long, slender for two-thirds of its length, then suddenly and strongly swollen; no reticulation or imbrications present. The cauda is twisted, but it is light colored and appears to be long and broad with three pairs of lateral hairs.

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 0. 416 | 27 | 0. 272 | 13 | 0. 272 | 6 | 0. 096+0. 896 |
| 0. 416 | 29 | 0. 272 | 12 | 0. 272 | 4 | 0. 096+0. 880 |

*Cornicle*

| Length | Wide X | Small X | Flange |
|---|---|---|---|
| 0. 384 | 0. 064 | 0. 032 | 0. 040 |

*Type.*—Returned to Maine Agricultural Experiment Station.

### AMPHOROPHORA MITCHELLI, new species

Figs. 127-129

A single alate viviparous female was taken on a wild Rhododendron on the top of Mount Mitchell, N. C., altitude 2,100 meters, by Carlo Zeimet on August 29, 1922. Mr. Zeimet says that two other specimens were observed at the same time but were not captured. This is evidently a native species of the wild forest, as no cultivated areas were close at hand. The following description and the drawings are from the one specimen. No other records have been received.

*Alate viviparous female.*—Antennae longer than the body, black, heavily tuberculate; hairs conspicuous, not capitate, about 0.32 mm. long. Antennal measurements as follows:

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 1. 072 mm. | 124 | 0. 544 | 45 | 0. 416 | 5 | 0. 104+1. 088 |
| 1. 088 | 112 | 0. 512 | 44 | 0. 464 | 10 | 0. 096+1. 056 |

Antennal tubercles small. Head 0.496 mm. across eyes. Head and thorax dark and abdomen light, in balsam mount. No thoracic or abdominal tubercles showing. Cornicles light at base, remainder black. Measurements as follows:

| Length | Reticulated | Wide X | Small X | Flange |
|---|---|---|---|---|
| 0. 576 | 0. 032 | 0. 120 | 0. 048 | 0. 056 |
| 0. 592 | 0. 032 | 0. 112 | 0. 048 | 0. 056 |

Cauda lighter in color than cornicles, 0.336 mm. long, slender, 4 sets of lateral hairs.

*Type.*—(Q No. 20138). Deposited in U. S. National Museum. Cat. No. 26374.

### AMPHOROPHORA MORRISONI (Swain)

Figs. 92–97

*Nectarosiphon morrisoni* SWAIN, Trans. Amer. Ent. Soc., vol. 44, no. 772, 1918, p. 8; Univ. Cal. Pub. Tech. Bull. Ent., vol. 3, no. 1, 1919, p. 78.

Descriptions and measurements from 11 slides furnished by Harold Morrison, after whom the species was named.

*Alate viviparous female.*—This is a comparatively small species with antennae about one and one-half times as long as the body. Segments slender, not conspicuously imbricated; hairs few and small, III with 7 to 11 small circular sensoria in a row on the outer edge. Antennal tubercles of moderate size. Beak reaching beyond third coxae. Cornicles long, conspicuously swollen, distinctly reticulated at tip. The cauda is long, conical, not constricted, with 3–4 sets of lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 624 | 9 | 0. 544 | 0. 560 | 0. 176+0. 752 |
|  | 0. 608 | 9 | 0. 560 | 0. 608 | 0. 192+ ? |
| 2 | 0. 608 | 10 | 0. 496 | 0. 592 | 0. 208+0. 800 |
|  | 0. 592 | 7 | 0. 480 | 0. 544 | 0. 176+0. 688 |
| 3 | 0. 496 | 11 | 0. 448 | 0. 464 | 0. 176+0. 736 |
|  | 0. 464 | 8 | 0. 400 | 0. 464 | 0. 160+ ? |
| 4 | 0. 608 | 9 | 0. 512 | ? | ? ? |
|  | 0. 608 | 9 | 0. 480 | 0. 496 | 0. 176+0. 176 |
| 5 | 0. 624 | 9 | 0. 480 | 0. 496 | 0. 192+0. 720 |
|  | 0. 624 | 6+ | 0. 496 | ? | ? ? |

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 512 | 0. 272 | 0. 688 | 0. 08 | 0. 128 | 0. 048 | 0. 064 |
| | | | 0. 656 | 0. 08 | ? | ? | 0. 064 |
| 2 | ? | 0. 304 | 0. 640 | 0. 08 | ? | 0. 040 | 0. 064 |
| | | | 0. 640 | 0. 08 | ? | ? | 0. 064 |
| 3 | 0. 496 | 0. 224 | 0. 560 | 0. 08 | 0. 112 | 0. 048 | 0. 064 |
| | | | 0. 608 | 0. 08 | 0. 112 | 0. 048 | 0. 064 |
| 4 | ? | 0. 240 | 0. 592 | 0. 08 | 0. 104 | 0. 048 | 0. 064 |
| | | | 0. 592 | 0. 08 | 0. 096 | 0. 048 | 0. 064 |
| 5 | 0. 480 | 0. 304 | 0. 656 | ? | 0. 112 | 0. 048 | 0. 064 |
| | | | ? | ? | ? | ? | ? |

Mr. Morrison furnishes from his notes the following color descriptions:

"General color green (pale and dark apple). Head pale green, slightly yellowish. Eyes dark brown, appearing almost black. Ocelli pale, spots black. Antennal segments I and II like head, yellowish pale green, rest black or blackish. Base of III like I and II. Prothorax dark pale green, front edge Prussian green, hinder edge darker. Thorax, ground color apple green, the median cephalic lobe light Van Dyke brown, and the two dorsal lateral, each with a large outer brown spot and a smaller inner one. A lateral lobe on each side below wings light Van Dyke brown. Wing inserts and base of subcosta very pale green. Subcosta and stigma grayish. Veins brown, dark. Beak, III black, II dusky, tip of I dusky, I pale green. Femora pale green, tips dusky, tibia and tarsi blackish or black. Abdomen uniform dark apple green. Ventral anal plate with indistinct dusky band. Cauda like the abdomen, or very slightly paler. Cornicles pale apple green at base, rest dusky to blackish, tips a little lighter."

Specimens collected about a month later show the following differences:

"Head quite yellowish (greenish yellow). The prothorax is brownish pale green, with a darker line along the front edge, and with the hind margin no darker, the membrane between it and thorax being light Hooker's green. The ground color of the thorax appears in these specimens to be brown (pale) with the lobes mentioned in the first description only a little darker. It requires a careful examination to separate the inner and outer lobes of the thorax, as there is only a narrow line of color between them. The median caudal lobe projecting into the abdomen is somewhat blackish and the darkest of all. The abdomen shows a very faint darker stripe down the center. Cauda distinctly but only slightly lighter than abdomen. Cornicles no lighter at tip."

*Apterous viviparous female.*—Size small, body oval, antennae one and one-fourth to one and one-half times as long as body, slender, faintly imbricated, hairs small, III with one to six, usually one, small circular sensoria near base. Antennal tubercles of moderate size. Beak reaching beyond third coxae. Cornicles distinctly but moderately swollen, distinctly reticulated at tip. Cauda broad, not constricted, three sets of lateral hairs. Measurements as follows:

*Antennal segments*

| No. | III | IV | V | VI |
|---|---|---|---|---|
| 1 | 0. 592 | 0. 496 | 0. 480 | 0. 176+0. 576 |
|  | 0. 592 | 0. 480 | 0. 480 | 0. 160+0. 592 |
| 2 | 0. 624 | 0. 480 | 0. 480 | 0. 176+0. 720 |
|  | 0. 608 | 0. 400 | 0. 448 | 0. 176+0. 656 |
| 3 | 0. 640 | 0. 496 | ? | ? |
|  | 0. 624 | 0. 496 | 0. 512 | 0. 176+0. 704 |
| 4 | 0. 624 | 0. 464 | 0. 480 | 0. 192+0. 752 |
|  | 0. 624 | 0. 464 | 0. 480 | 0. 176+0. 720 |
| 5 | 0. 496 | ? | ? | ? |
|  | 0. 448 | 0. 352 | 0. 384 | 0. 144+0. 512 |
| 6 | 0. 528 | 0. 400 | 0. 400 | 0. 144+0. 592 |
|  | 0. 544 | 0. 384 | 0. 384 | 0. 144+0. 592 |
| 7 | 0. 528 | 0. 384 | 0. 464 | 0. 160+0. 672 |
|  | 0. 528 | 0. 400 | 0. 464 | 0. 160+0. 608 |

| No. | Width of head | Cauda | Cornicles |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 496 | 0. 224 | 0. 752 | 0. 080 | 0. 112 | 0. 048 | 0. 064 |
|  |  |  | 0. 704 | 0. 080 | 0. 112 | 0. 056 | 0. 072 |
| 2 | 0. 480 | 0. 320 | 0. 736 | 0. 080 | 0. 112 | 0. 056 | 0. 072 |
|  |  |  | 0. 752 | 0. 080 | 0. 112 | 0. 056 | 0. 072 |
| 3 | 0. 480 | 0. 336 | 0. 720 | 0. 080 | 0. 096 | 0. 048 | 0. 064 |
|  |  |  | 0. 704 | 0. 080 | 0. 096 | 0. 048 | 0. 064 |
| 4 | -------- | -------- | 0. 672 | 0. 080 | 0. 128 | 0. 056 | 0. 064 |
| 5 | 0. 432 | ? | 0. 448 | 0. 064 | 0. 112 | 0. 048 | 0. 056 |
|  |  |  | 0. 480 | 0. 064 | 0. 096 | 0. 048 | 0. 064 |
| 6 | 0. 416 | ? | 0. 592 | 0. 080 | 0. 128 | 0. 048 | 0. 064 |
|  |  |  | 0. 592 | 0. 080 | 0. 104 | 0. 048 | 0. 064 |
| 7 | 0. 480 | 0. 240 | 0. 624 | 0. 096 | 0. 112 | 0. 048 | 0. 064 |
|  |  |  | 0. 608 | 0. 080 | 0. 112 | 0. 058 | 0. 072 |

Morrison furnishes the following color description from his note files:

"General color green (dark apple to Hooker's green). Head pale green. Eyes very dark brown, almost black. Antennal segments I and II pale green, slightly yellowish green. Base of III similar, remainder black. Thorax dark apple green, shading imperceptibly into Hooker's green on the abdomen. Abdomen Hooker's green, edges paler. Last segment dark apple green. Cauda apple green. Cornicles, base apple green shading into dusky, tips black. Femora dusky pale green. Tibia dusky yellow, tips and tarsi black. Last abdominal segment and cauda in some specimens distinctly pale green."

This species was first found on *Cupressus* in the Stanford University nursery by Childs and Crawford on February 21, 1912, and the above color notes were written by Morrison on this date. Both alate and apterous forms were present. It was taken again at the same place on March 17, 1912, and April 14, 1912. It was again taken by Morrison on May 21, 1915, in Golden Gate Park, San Francisco, alate and apterous adults and apterous nymphs, and by Harold Compere at the same place during the same month. In August, 1916, Swain found the apterous form on terminal leaves in Exposition Park, San Diego.

*Host plants.*—*Cupressus macrocarpa* and *C. guadalupensis.*

*Distribution.*—California (San Francisco, Palo Alto, and San Diego).

*Cotypes.*—Deposited in the U. S. National Museum. Cat. No. 26856.

*Paracotypes.*—Deposited in the University of California collection, No. EOE 88, and in the Swain collection of Leland Stanford University. Specimens from Harold Morrison are in his collection and in that of the U. S. National Museum.

### AMPHOROPHORA NABALI (Oestlund)

Figs. 118–126, 194

***Rhopalosiphum nabali*** OESTLUND, 14th Report, Minn. State Geol., 1886, p. 34; Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, p. 77.—WILLIAMS, Univ. Neb. Spec. Bull. 1, 1891, p. 26.—HUNTER, Iowa Agr. Exp. Sta. Bull. 60, 1901, p. 106.—KIRKALDY, Can. Ent., vol. 38, 1906, p. 12.—SANBORN, Kans. Univ. Sci. Bull., vol. 3, no. 8, 1906, p. 241.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 113.

***Amphorophora nabali*** (Oestlund) PATCH, Conn. St. Geol. and Nat. Hist. Surv. Bull., no. 34, 1923, p. 302.

There is in the national collection a metatype slide, containing two adult alate viviparous females, two alate nymphs, one apterous viviparous female, and one intermediate. This collection was made in Minnesota from *Nabalus albus* on July 11, 1903, by Pergande and determined by Oestlund. All drawings were made from this slide, and the following descriptions are chiefly from this slide, supplemented by comparisons with certain other specimens.

*Alate viviparous female.*—Antennae longer than body, dark colored, segments III, IV, and V very tuberculate for their entire lengths; one specimen with only a few on V; hairs conspicuous and heavy with a tendency to be knobbed. Antennal tubercles rather short. Beak reaching second coxae. Radial sector going somewhat closer to medius than is usual for the genus. Cornicles medium in length, considerably swollen, imbricated, very indistinctly reticulated, if at all. Cauda long, slender, conspicuously constricted, with 4 sets of lateral hairs. Most of the hairs of the body more or less capitate.

*Antennal measurements*

| No. | III | IV | V | VI |
|---|---|---|---|---|
| 1 | 1.136 mm. | 0.528 | 0.464 | 0.096+0.768 |
|  | 1.072 | 0.528 | 0.496 | 0.096+(0.432+) |
| 2 | 1.056 | 0.528 | 0.432 | 0.096+(0.416+) |

*Other measurements*

| No. | Width of head | Cauda | Cornicles |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1 | 0.528 | 0.400 | 0.640 | 0.120 | 0.048 | 0.064 |
| 2 | 0.544 | 0.448 | 0.688 | 0.136 | 0.048 | 0.064 |

Pergande left, in his notes, the following color description, made from the metatype specimens:

"Head yellowish, eyes brown, ocelli clear, bordered at inner side with purplish brown. Antennae black. Prothorax greenish, thoracic lobes brownish yellow. Abdomen green, variegated with yellowish green. Nectaries dusky, greenish toward base. Legs black, the femora yellowish green at base, growing darker toward or beyond the middle. Stigma dusky, blackish along inner edge. Subcosta yellowish."

*Last instar alate nymph*

| III | IV | V | VI | Head width | Cornicle length |
|---|---|---|---|---|---|
| 0.560 | 0.352 | 0.336 | 0.080+0.832 | 0.496 | 0.560 |
| 0.576 | 0.336 | 0.336 | 0.080+0.816 | ---------- | 0.560 |
| 0.576 | 0.368 | 0.336 | 0.096+0.928 | 0.528 | 0.544 |
| 0.624 | 0.384 | 0.352 | 0.080+0.848 | ---------- | 0.544 |
| 0.672 | 0.384 | 0.320 | 0.096+0.928 | 0.528 | 0.512 |
| 0.656 | 0.352 | 0.336 | 0.096+0.976 | ---------- | 0.528 |

*Third instar alate nymph*

| III | IV | V | VI | Head width | Cornicle length |
|---|---|---|---|---|---|
| 0.480 | 0.288 | 0.288 | 0.08+(0.56+) | 0.496 | 0.480 |
| 0.560 | 0.288 | 0.288 | 0.08+0.832 | ---------- | 0.480 |

Pergande says of the metatypes: "Pupae green; wing pads yellowish; antennae yellowish or greenish with apex of joints 3–5 and the 6th black."

*Apterous viviparous female.*—Antennae longer than body, with conspicuous knobbed hairs, III with from 3 to 15 sensoria. Antennal tubercles prominent. Beak reaching second coxae. Cornicles of medium length, conspicuously swollen, tips imbricated, sometimes with indications of reticulations. Cauda long, slender, constricted, three sets of lateral hairs.

*Antennal measurements*

| No. | III | IV | V | VI |
|---|---|---|---|---|
| 1 | 0. 912 | 0. 544 | 0. 480 | 0. 096+0. 960 |
| | 0. 896 | 0. 528 | 0. 464 | 0. 112+1. 088 |
| 2 | 0. 880 | 0. 464 | 0. 368 | 0. 080+1. 008 |
| | 0. 880 | 0. 432 | 0. 384 | 0. 096+0. 992 |
| 3 | 0. 896 | 0. 400 | 0. 416 | 0. 096+(0. 656+) |
| | 0. 912 | 0. 432 | 0. 432 | 0. 096+0. 960 |
| 4 | 0. 880 | 0. 496 | 0. 464 | 0. 112+1. 104 |
| | 0. 928 | 0. 480 | 0. 432 | 0. 112+1. 120 |

*Other measurements*

| No. | Head width | Cauda | Cornicles | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 480 | 0. 432 | 0. 688 | 0. 128 | 0. 048 | 0. 064 |
| | | | 0. 704 | 0. 128 | 0. 048 | 0. 064 |
| 2 | 0. 448 | 0. 368 | 0. 592 | 0. 112 | 0. 048 | 0. 056 |
| | | | 0. 608 | 0. 120 | 0. 048 | 0. 064 |
| 3 | 0. 464 | 0. 416 | 0. 592 | 0. 112 | 0. 048 | 0. 064 |
| | | | 0. 656 | 0. 112 | 0. 048 | 0. 064 |
| 4 | 0. 480 | 0. 400 | 0. 688 | 0. 112 | 0. 048 | 0. 064 |
| | | | 0. 704 | 0. 112 | 0. 048 | 0. 064 |

*Last instar apterous nymph*

| III | IV | V | VI | Head width | Cornicle length |
|---|---|---|---|---|---|
| 0. 400 | 0. 224 | 0. 224 | 0. 08+0. 736 | 0. 448 | 0. 480 |
| 0. 400 | 0. 224 | 0. 224 | 0. 08+0. 752 | ---------- | 0. 480 |
| 0. 496 | 0. 288 | 0. 304 | 0. 08+0. 912 | 0. 464 | 0. 496 |
| 0. 512 | 0. 288 | 0. 304 | 0. 08+0. 864 | ---------- | 0. 496 |

Pergande's notes furnish the following color description of the metatype apterous female: "Green, polished; eyes brown; nectaries pale greenish yellow at basal half, the other half brown; tail greenish or dusky. Antennae dusky to black; if pale, the apex of jts. 3–5 and the 6th with spur black; femora pale bluish green; tibiae brownish yellow, greenish at base; apex and tarsi black."

It is probable that Pergande referred to the intermediate when he said "antennae dusky to black" as the second part of his description, "pale, the apex of jts. 3–5 and the 6th with spur black," seems to apply better to the apterous forms.

*Intermediate.*—The one specimen available (metatype specimen) has antennae which are intermediate in color between the black ones of the alates and the lighter ones of the apterous forms. Both antennae are abortive, one having only a very short fifth segment and no sixth, while the other has the fifth, base of sixth and a very short unguis. III and IV are thickly covered with rather small sensoria. V of the one antenna has six small inconspicuous sensoria. No ocelli showing. Wings very small and abortive, about equally developed on each side, hooks showing on both hind wings. Cornicles and cauda appearing about as in the alate and apterous forms. Measurements as follows:

| III | IV | V | VI | Head width | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Length | Wide X | Small X | Flange |
| 1. 008 | 0. 528 | 0. 384 | 0. 096+0. 08 | 0. 56 | 0. 464 | 0. 800 | 0. 128 | 0. 048 | 0. 064 |
| 0. 944 | 0. 480 | 0. 144 | ------------ | ----- | ------ | 0. 784 | 0. 136 | 0. 056 | 0. 072 |

Oestlund reported this species as "very numerous on the upper stalk and flower heads of *Nabalus albus*." Pergande took them on the stem and under side of leaves. Miss Patch says it is not uncommon in the east.

The only dates recorded are September 28, 1897, at Zoological Park, D. C., and July 11, 1903, at Minneapolis, Minn., both by Pergande.

*Host.*—*Nabalus albus.*

*Distribution.*—Minnesota, District of Columbia, Connecticut.

*Metatype.*—Deposited in U. S. National Museum.

### AMPHOROPHORA NERVATA (Gillette)

Figs. 130–138

*Rhopalosiphum nervatum* GILLETTE, Canad. Ent., vol. 40, 1908, p. 63.—DAVIDSON, Journ. Ec. Ent., vol. 7, 1914, p. 134.—ESSIG, Univ. Cal. Pub. Tech. Bull. Agr. Exp. Sta. Ent., vol. 1, no. 7, 1917, p. 331.—SWAIN, Univ. Cal. Pub. Tech. Bulls. Agr. Exp. Sta. Ent., vol. 3, no. 1, 1919, p. 84.—PATCH, Maine Agr. Exp. Sta. Bull. 282, 1919, p. 220.

*Rhopalosiphum arbuti* DAVIDSON, Journ. Econ. Ent., vol. 3, 1910, p. 378.—ESSIG, Univ. Cal. Pub. Tech. Bulls. Agr. Exp. Sta. Ent., vol. 1, no. 7, 1917, p.331.

The writer has had the privilege of examining the cotype specimens of *nervatum* Gill. from rose and of *arbuti* Davisdon from *Arbutus* and considers them to be the same as has already been pointed out by others. The amount of dilation of the cornicle varies somewhat, some specimens being only very slightly swollen, but the species undoubtedly should be placed in *Amphorophora.*

*Alate viviparous Female.*—Rather small. Antennae slender, dark colored, about one and one-half times as long as body, imbricated, hairs small and inconspicuous, III with a row of sensoria along outer, basal edge. Antennal tubercles moderate in size. Beak reaching second coxae. Cornicles long, slender, not strongly swollen, conspicuously imbricated, not reticulated. Cauda long, conical, only slightly constricted, two sets of lateral hairs.

*Antennal measurements*

| No. | III | Sensoria | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0.592 | 13 | 0.448 | 0.392 | 0.128+0.800 |
| 2 | 0.640 | 16 | 0.432 | 0.424 | 0.144+0.848 |
|  | 0.624 | 14 | 0.464 | ? | ? |
| 3 | 0.576 | 14 | 0.416 | 0.432 | 0.152+0.800 |
| 4 | 0.560 | 14 | 0.448 | 0.448 | 0.144+(0.496+) |
|  | 0.544 | 13 | 0.416 | 0.368 | 0.128+0.752 |
| 5 | 0.608 | 15 | 0.480 | 0.432 | 0.144+0.848 |
|  | 0.624 | 15 | 0.480 | 0.448 | 0.144+0.848 |
| 6 | 0.624 | 15 | 0.560 | ? | ? |
|  | 0.640 | 12 | 0.544 | 0.544 | 0.176+0.992 |
| 7 | 0.432 | 13 | 0.368 | 0.336 | 0.112+0.800 |
|  | 0.432 | ? | 0.368 | 0.336 | 0.112+? |
| 8 | 0.592 | 14 | 0.432 | 0.432 | 0.128+0.752 |
|  | 0.624 | ? | 0.400 | 0.400 | 0.128+0.752 |
| 9 | 0.672 | 17 | 0.592 | 0.480 | 0.144+0.976 |
|  | 0.704 | ? | 0.560 | 0.480 | 0.144+0.992 |
| 10 | 0.448 | 12 | 0.352 | 0.360 | 0.128+0.848 |
|  | 0.448 | 11 | 0.352 | 0.368 | 0.128+0.848 |

*Other measurements*

| No. | Head width | Cauda | Length | Wide X | Small X | Flange |
|---|---|---|---|---|---|---|
| 1 | 0.408 | 0.240 | 0.608 | 0.056 | 0.040 | 0.048 |
|  |  |  | 0.608 | 0.064 | 0.040 | 0.048 |
| 2 | ? | 0.240 | 0.624 | 0.064 | 0.040 | 0.048 |
|  |  |  | 0.560 | 0.064 | 0.040 | 0.056 |
| 3 | ? | 0.240 | 0.624 | 0.056 | 0.040 | 0.048 |
|  |  |  | 0.608 | 0.056 | 0.040 | 0.048 |
| 4 | 0.384 | 0.176 | 0.528 | 0.056 | 0.040 | 0.048 |
|  |  |  | 0.528 | 0.048 | 0.032 | 0.048 |
| 5 | ? | 0.256 | 0.640 | 0.056 | 0.040 | 0.048 |
|  |  |  | ? | 0.048 | 0.032 | 0.040 |
| 6 | 0.440 | 0.272 | 0.688 | 0.072 | 0.040 | 0.056 |
|  |  |  | 0.688 | 0.072 | 0.040 | 0.056 |
| 7 | 0.352 | 0.128 | 0.464 | 0.056 | 0.032 | 0.040 |
|  |  |  | 0.480 | 0.056 | 0.032 | 0.040 |
| 8 | 0.384 | 0.224 | 0.592 | 0.056 | 0.040 | 0.048 |
|  |  |  | 0.560 | 0.064 | 0.040 | 0.048 |
| 9 | 0.416 | 0.256 | 0.768 | 0.064 | 0.032 | 0.048 |
|  |  |  | 0.768 | 0.072 | 0.040 | 0.056 |
| 10 | 0.368 | ? | 0.512 | 0.048 | 0.032 | 0.040 |

Davidson in his description of *arbuti* says, "Joint III has about 20 small sensoria, joint IV about 8 smaller ones." I have been unable to see any sensoria on IV in the specimens which he furnished me.

*Apterous viviparous female.*—Small. Antennae nearly twice as long as body, light colored, the tips of segments and all of VI darker, faintly imbricated, hairs inconspicuous, no secondary sensoria. Antennal sensoria prominent. Beak reaching third coxae. Cornicles long, slender, slightly but distinctly swollen, imbricated, not reticulated. Cauda very broad, scarcely constricted, with two sets of lateral hairs.

*Antennal measurements*

| No. | III | IV | V | VI |
|---|---|---|---|---|
| 1 | 0. 608 | 0. 448 | 0. 400 | 0. 128+(0. 576+) |
| | 0. 608 | 0. 416 | 0. 368 | 0. 128+(0. 256+) |
| 2 | 0. 528 | 0. 320 | 0. 336 | 0. 112+0. 736 |
| | 0. 528 | 0. 320 | 0. 320 | 0. 112+0. 704 |
| 3 | 0. 576 | 0. 384 | 0. 336 | 0. 120+0. 816 |
| | 0. 560 | 0. 384 | 0. 352 | 0. 112+0. 800 |
| 4 | 0. 480 | 0. 352 | 0. 320 | 0. 112+(0. 656+) |
| | 0. 464 | 0. 352 | 0. 320 | 0. 112+0. 752 |
| 5 | 0. 640 | 0. 496 | 0. 416 | 0. 136+0. 864 |
| | 0. 672 | 0. 512 | 0. 416 | 0. 128+0. 848 |
| 6 | 0. 720 | 0. 624 | 0. 504 | 0. 152+(0. 784+) |
| | 0. 752 | 0. 640 | 0. 496 | 0. 160+0. 928 |
| 7 | 0. 576 | 0. 464 | 0. 400 | 0. 144+0. 800 |
| | 0. 560 | 0. 448 | 0. 384 | 0. 144+0. 784 |
| 8 | 0. 592 | 0. 432 | 0. 416 | 0. 136+0. 816 |
| | 0. 592 | 0. 448 | 0. 384 | 0. 128+0. 720 |
| 9 | 0. 544 | 0. 432 | 0. 368 | 0. 128+0. 688 |
| | 0. 528 | 0. 416 | 0. 384 | 0. 144+0. 784 |
| 10 | 0. 560 | 0. 448 | 0. 384 | 0. 128+0. 720 |
| | 0. 544 | ? | ? | ? |

*Other measurements*

| No. | Head width | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 400 | 0. 304 | 0. 656 | 0. 064 | 0. 040 | 0. 056 |
| | | | 0. 656 | 0. 064 | 0. 040 | 0. 048 |
| 2 | 0. 368 | 0. 352 | 0. 528 | 0. 064 | 0. 040 | 0. 048 |
| | | | 0. 528 | 0. 064 | 0. 040 | ? |
| 3 | ? | 0. 256 | 0. 576 | 0. 064 | 0. 032 | 0. 048 |
| | | | ? | 0. 064 | 0. 032 | 0. 048 |
| 4 | 0. 352 | 0. 208 | 0. 560 | 0. 072 | 0. 032 | 0. 048 |
| | | | 0. 560 | 0. 072 | 0. 032 | 0. 048 |
| 5 | 0. 400 | 0. 240 | 0. 720 | 0. 080 | 0. 040 | 0. 048 |
| | | | 0. 704 | 0. 080 | 0. 040 | 0. 048 |
| 6 | 0. 424 | 0. 320 | 0. 864 | 0. 096 | 0. 040 | 0. 048 |
| | | | 0. 864 | 0. 088 | 0. 040 | 0. 048 |
| 7 | 0. 392 | 0. 256 | 0. 752 | 0. 072 | 0. 040 | 0. 048 |
| | | | 0. 720 | 0. 064 | 0. 040 | 0. 048 |
| 8 | 0. 368 | 0. 256 | 0. 640 | 0. 064 | 0. 040 | 0. 048 |
| 9 | 0. 392 | 0. 240 | 0. 640 | 0. 064 | 0. 040 | 0. 048 |
| 10 | 0. 400 | ? | 0. 736 | 0. 080 | 0. 040 | 0. 048 |

The last instar nymph of the apterous viviparous female measures as follows:

| III | IV | V | VI | Head width | Cornicle length |
|---|---|---|---|---|---|
| 0.448<br>0.432 | 0.384<br>0.416 | 0.336<br>0.352 | 0.096+0.768<br>0.096+0.752 | 0.400<br>---------- | 0.448<br>0.480 |

*Alate male.*—Antennae slightly more than one and one-half times as long as body, imbricated especially beyond III, inner side of I gibbous, III 0.608 mm. long with 30 sensoria, IV 0.512 mm. long with 16–17 sensoria, V 0.464, mm. long with 12–14 sensoria, base of VI 0.144 mm. long, unguis 0.792 mm. long. Antennal tubercles moderate in size. Head 0.416 mm. across eyes. Cornicles 0.624 mm. long, widest diameter 0.064 mm., smallest diameter 0.040 mm., flange 0.048 mm. wide, conspicuously imbricated, not reticulated. From one metatype specimen on rose at Fort Collins, Colo., November 3, 1914.

*Biology.*—In California this species seems to migrate between rose and *Arbutus*. The only transfer was made by Swain. I agree with him and with Essig that *arbuti* Davidson from *Arbutus* seems to be structually the same as *nervata* Gillette on rose. The writings of Davidson and Gillette would indicate that the species may be found throughout the year on either plant.

*Host plants.*—Rose, *Arbutus menzeisii*, *Arbutus unedo* Linnaeus, *Photinia arbutifolia* and *Arctostaphylos manzanita* Parry.

*Distribution.*—Colorado and California.

*Cotypes.*—Specimens of *nervata* Gillette are in the collection of the U. S. National Museum, Cat. No. 26855, in the Colorado Agricultural Experiment Station, and in the Maine Agricultural Experiment Station. Those of *arbuti* Davidson are in the U. S. National Museum and in the collection of Davidson.

### AMPHOROPHORA OLERACEAE (Van der Goot)

Figs. 49–54

*Rhopalosiphum lactucae* (Kaltenbach) MAKI, Bull. Agr. Exp. Sta. Formosa No. 103, 1913, p. 22.

*Rhopalosiphum oleraceae* VAN DER GOOT, Zur Kenntniss der Blattlause Java's 1917, p. 40.

*Amphorophora oleraceae* (Van der Goot) TAKAHASHI, Aphididae of Formosa, pt. 1, Form. Agr. Exp. Sta. 1921, p. 28; Rev. Form. Agr., no. 182, 1921, p. 63.

*Amphorophora sonchifoliae* TAKAHASHI, Aphididae of Formosa, pt. 2, Rept. Agr. Gov. Res. Inst. Formosa, no. 4, 1923, pp. 31 and 84.

This species is very close to *cosmopolitana* and is found on the same summer hosts. It can be distinguished by the larger number of sensoria, especially in the apterous form. The sensoria are not quite as protruding, the hairs are less conspicuous, and the antennal tubercles are slightly larger.

Takahashi has described *Amphorophora sonchifoliae* as a new species on *Sonchus arvensis*. He says, "closely related to *A. oleraceae* (v. d. Goot), from which it differs in the more slender cornicles." He says the cornicles of the alate form are eight times as long as wide, while those of the apterous form are seven times as long as wide. I have compared apterous specimens sent by Takahashi with metatype specimens of *oleraceae* v. d. Goot. While there are some slight differences, I can not at present consider the two as distinct. (See discussion on p. 4.) In the tables of measurements given below I have separated those of *sonchifoliae* from *oleraceae* for the benefit of those who have not seen specimens.

*Alate viviparous female* (*oleraceae* v. d. Goot).—Antennae about the same length as the body, dark, hairs very inconspicuous (more so than in *cosmopolitana*), numerous rather large, but not strongly protruding sensoria on III, IV, and V. Antennal tubercles small, but somewhat larger than in *cosmopolitana*. Beak reaching about to second coxae. Small prothoracic tubercles. Abdomen bearing a middorsal dark area and lateral dark patches, these having a tubercle and spines as in *cosmopolitana*. Cornicles of moderate length, somewhat swollen, the tips imbricated, not reticulated. Cauda constricted, three to four sets of hairs.

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1 | 0. 720 | 46 | 0. 448 | 27 | 0. 400 | 12 | 0. 128+0. 800 |
| 2 | 0. 736 | 51 | 0. 448 | 27 | ? | ? | ? |

| No. | Head | Cauda | Cornicle |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1 | 0. 448 | 0. 272 | 0. 480 | 0. 064 | 0. 032 | 0. 040 |
|  |  |  | 0. 480 | 0. 064 | 0. 032 | 0. 040 |
| 2 | 0. 472 | 0. 256 | 0. 464 | 0. 072 | 0. 032 | 0. 040 |

*Apterous viviparous female* (*oleraceae* v. d. Goot.)—Antennae slightly longer than body, light colored, tips of segments darker, hairs very inconspicuous, III, IV, and V with large, nonprotruding sensoria. Antennal tubercles of moderate size. Beak reaching beyond second coxae, nearly to third. Cornicles short, moderately swollen, the tip imbricated, not reticulated. Cauda strongly constricted, three sets of lateral hairs.

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1 | 0.640 | 28 | 0.368 | 10 | 0.360 | 4 | 0.128+? |
| 2 | 0.640 | 26 | 0.416 | 10 | 0.344 | 6 | 0.128+0.688 |
|  | 0.688 | 27 | 0.424 | 10 | 0.352 | 5 | 0.136+0.704 |
| 3 | 0.640 | 22 | ? | ? | ? | ? | ? |

| No. | Head | Cauda | Cornicle |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1 | ? | 0.272 | 0.464 | 0.080 | 0.040 | 0.048 |
| 2 | ? | 0.256 | 0.520 | 0.064 | 0.040 | 0.040 |
|  |  |  | 0.512 | 0.064 | 0.040 | 0.040 |
| 3 | 0.456 | 0.304 | 0.448 | 0.072 | 0.040 | 0.040 |

*Measurements of A. sonchifoliae* Takahashi

| No. | III | Sen. on III | IV | Sen. on IV | V | Sen. on V | VI |
|---|---|---|---|---|---|---|---|
| 1 | 0.656 | 31 | 0.408 | 8 | 0.376 | 2 | 0.136+0.768 |
|  | 0.672 | 24 | 0.400 | 10 | 0.384 | 2 | 0.144+0.752 |
| 2 | 0.624 | 26 | 0.384 | 7 | 0.336 | 1 | 0.112+0.672 |
|  | 0.608 | 22 | 0.368 | 5 | 0.352 | 0 | 0.120+? |

| No. | Head | Cauda | Cornicle |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Length | Wide X | Small X | Flange |
| 1 | ? | 0.208 | 0.480 | 0.060 | 0.040 | 0.048 |
|  |  |  | 0.480 | 0.060 | 0.040 | 0.048 |
| 2 | ? | 0.288 | 0.464 | 0.064 | 0.040 | 0.048 |

*Host.*—*Sonchus* species, *Lactuca debilis.*

*Distribution.*—Java, Formosa.

*Metatype.*—Specimens in collection of U. S. National Museum.

### AMPHOROPHORA PALLIDA, new species

Figs. 55–58

This species was received from Dr. Edith M. Patch under the manuscript name of *pallida*. At her suggestion it is described in this paper, and I take pleasure in adopting her manuscript name. It was taken on *Clintonia* at Orono, Me., on August 8, 1918 (Maine No. 288–18 and 289–18). Three adult and several nymphal apterous viviparous females were received. No alates.

*Apterous viviparous female.*—Antennae about one and one-half times as long as body, slightly darker in color, indistinctly imbricated, hairs inconspicuous, shorter than width of segment, III with 2–3 sensoria near base. Antennal tubercles very large and long. Beak reaching beyond second coxae, nearly to third. No prothoracic or abdominal tubercles. Cornicles very light colored, long, strongly dilated on distal half, but not much reduced at flange, reticulated for a short distance, not imbricated. Cauda concolorous with body, long, broad, strongly constricted at base; two sets of lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0.656 | 3 | 0.560 | 0.528 | 0.144+0.960 |
|  | 0.656 | 2 | 0.560 | 0.536 | 0.160+0.992 |
| 2 | 0.568 | 3 | 0.512 | 0.544 | 0.152+1.024 |
|  | 0.592 | 3 | 0.488 | 0.544 | 0.144+1.040 |
| 3 | 0.688 | 2 | 0.560 | 0.536 | 0.168+ ? |
|  | 0.672 | 2 | 0.560 | 0.544 | ? |

| No. | Head | Cauda | Cornicle |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0.432 | 0.320 | 0.560 | 0.040 | ? | ? | 0.056 |
|  |  |  | 0.560 | 0.040 | ? | ? | 0.056 |
| 2 | 0.384 | 0.224 | 0.496 | 0.040 | 0.080 | ? | 0.048 |
| 3 | 0.368 | 0.320 | 0.560 | 0.040 | 0.096 | 0.048 | 0.056 |
|  |  |  | 0.584 | 0.040 | 0.096 | 0.056 | 0.048 |

*Host.*—*Clintonia.*

*Distribution.*—Orono, Maine.

*Cotypes.*—Returned to Maine Agricultural Experiment Station.

### AMPHOROPHORA PERGANDEI, new species

Figs. 72–77

Pergande took the apterous forms of this species on the under side of currant leaves at Washington, D. C., on May 6, 1897. On May 12 he reared from them a single alate specimen. These cotype specimens furnish the only records we have of the species.

This species can be distinguished from *cosmopolitana* on the same host by the larger number of sensoria and by the very long, capitate hairs of the antennae.

*Alate viviparous female.*—Antennae about twice as long as body, dark colored, very tuberculate, III with 125–130 sensoria, IV with 40–45 sensoria, V with 5–8 sensoria, hairs capitate and as long as or longer than width of segment. Antennal tubercles of moderate size. Beak reaching about to second coxae. Prothoracic tubercles not showing. Abdomen without the lateral dark patches as in *cosmopolitana.* Cornicles of moderate length, strongly swollen, dark colored, lighter at base, tips very faintly imbricated. Cauda very long, narrow, constricted, four sets of large lateral hairs.

| III | IV | V | VI |
|---|---|---|---|
| 1. 056 | 0. 576 | 0. 496 | 0. 112+1. 120 |
| 1. 072 | 0. 552 | 0. 496 | 0. 104+1. 104 |

| Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|
| | | Length | Wide X | Small X | Flange |
| 0. 528 | 0. 336 | 0. 560 | 0. 112 | 0. 048 | 0. 064 |
| | | 0. 544 | 0. 120 | 0. 048 | 0. 072 |

*Notes by Pergande.*—"Color green, thoracic lobes pale brownish; medio dorsal line darker green; nectaries grayish green, their basal one-third pale green. Antennae and legs black; basal half or three-fourths of femora greenish; two basal jts. of antennae dusky, base of first jt. yellowish, eyes brown. Stigma pale dusky; subcosta yellow, veins black."

*Apterous viviparous female.*—Antennae slightly longer than body, light colored, not plainly imbricated, hairs very conspicuous, capitate, as long as or longer than width of Segment III with 12–27 small sensoria at base, not in a row. Antennal tubercles fairly large. Beak reaching about to third coxae. Cornicles short and thick, plainly swollen, tips imbricated or slightly reticulated. Cauda very long, narrow, constricted, with 4–5 sets of lateral hairs.

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1----- | 0. 832 | 18 | 0. 496 | 0. 400 | 0. 096+1. 152 |
| | 0. 848 | 13 | 0. 464 | 0. 432 | 0. 104+ ? |
| 2----- | 0. 848 | 17 | 0. 480 | 0. 432 | 0. 112+1. 152 |
| | 0. 832 | 27 | 0. 496 | 0. 448 | 0. 104+1. 152 |
| 3----- | 0. 792 | 19 | 0. 512 | 0. 416 | 0. 112+0. 960 |
| | 0. 800 | 18 | 0. 496 | 0. 416 | 0. 096+0. 880 |
| 4----- | 0. 720 | 12 | 0. 384 | 0. 336 | 0. 088+0. 760 |
| 5----- | 0. 736 | 19 | 0. 432 | 0. 368 | 0. 104+0. 848 |
| | 0. 736 | 18 | 0. 432 | 0. 376 | 0. 104+0. 808 |
| 6----- | 0. 848 | 26 | 0. 528 | 0. 488 | 0. 128+1. 136 |
| | 0. 848 | 22 | 0. 512 | 0. 464 | 0. 120+1. 136 |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1----- | 0. 520 | 0. 416 | 0. 704 | 0. 120 | 0. 056 | 0. 072 |
| | | | | 0. 120 | 0. 056 | 0. 072 |
| 2----- | 0. 504 | ? | 0. 720 | 0. 120 | 0. 048 | 0. 072 |
| | | | 0. 720 | 0. 120 | 0. 056 | 0. 072 |
| 3----- | 0. 520 | 0. 416 | 0. 704 | 0. 128 | 0. 048 | 0. 064 |
| | | | 0. 672 | 0. 128 | 0. 048 | 0. 064 |
| 4----- | 0. 480 | 0. 400 | 0. 656 | 0. 120 | 0. 048 | 0. 064 |
| 5----- | 0. 480 | 0. 448 | 0. 672 | 0. 128 | 0. 048 | 0. 056 |
| | | | 0. 664 | 0. 128 | 0. 048 | 0. 064 |
| 6----- | 0. 512 | 0. 432 | 0. 704 | 0. 136 | 0. 056 | 0. 064 |
| | | | 0. 688 | 0. 128 | 0. 056 | 0. 072 |

*Notes by Pergande.*—"Color of all uniformly yellowish green; antennae, legs and nectaries paler; tips of antennal jts. 3 and 4 dusky; tip of the fifth and sixth and terminal half of the last black; tibiae brownish toward the end, the tarsi black."

Described from one alate and six apterous specimens taken by Pergande on currant at Washington, D. C.

*Cotypes.*—Deposited in U. S. National Museum. Cat. No. 26376.

### AMPHOROPHORA RETICULATA, new species

Figs. 142–143

*Alate viviparous female.*—Small species. Antennae more than twice as long as body, slender, dark colored, hairs inconspicuous, much shorter than width of segment, III with 20 sensoria in a row, I, II, and base of III lighter, concolorous with head. Antennal tubercles of moderate size. Beak reaching slightly beyond second coxae. No prothoracic or abdominal tubercles present. Cornicles uniformly dark colored, very long, slender, plainly swollen, very distinctly reticulate at tip. Cauda light colored, conical, not constricted, three sets of hairs. Measurements as follows:

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 0.672 | 20 | 0.544 | 0.592 | 0.176+0.880 |
| 0.672 | 20 | 0.568 | 0.624 | 0.192+0.880 |

| Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0.440 | 0.176 | 0.584 | 0.064 | 0.056 | 0.040 | 0.048 |
| | | 0.584 | 0.064 | 0.056 | 0.040 | 0.048 |

Described from one specimen taken by Pergande on raspberry in Washington, D. C., July 27, 1907.

*Type.*—Deposited in the U. S. National Museum. Cat. No. 26377

### AMPHOROPHORA RHODODENDRONIA, new species

Figs. 59–61

A slide bearing four apterous viviparous females was received from Dr. Edith M. Patch (Maine No. 168–22). These were taken on *Rhododendron rhodora* at Orono, Maine, July 21, 1922. They are not typical Amphorophora but no doubt should be placed here, at least until the alate in known. The host plant belongs to a family on which are several members of this genus of aphids.

*Apterous viviparous female.*—Antennae about one-third longer than body, imbricated, basal segments light colored, distal part of V and all of VI dark with 1–7 sensoria, hairs capitate and very conspicuous, especially on III. Antennal tuvercles very prominent. Beak reaching beyond second coxae. A small prothoracic tubercle showing on some specimens. Cornicles long, slender, slightly swollen, imbricated, tip dark and reticulated. Cauda long, conical, scarcely constricted, three sets of lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1.......... | 0.784 | 8 | 0.544 | 0.624 | 0.160+0.800 |
| | 0.784 | 6 | 0.608 | 0.576 | 0.176+ ? |
| 2.......... | 0.576 | 1 | 0.464 | 0.464 | 0.128+0.800 |
| 3.......... | 0.832 | 5 | 0.528 | 0.576 | 0.144+0.832 |
| | 0.816 | 4 | 0.560 | 0.560 | 0.144+0.848 |
| 4.......... | 0.656 | 3 | 0.528 | 0.544 | 0.168+0.800 |
| | 0.672 | 2 | 0.528 | 0.528 | 0.160+0.832 |

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1........ | 0.464 | 0.352 | 0.800 | 0.064 | 0.072 | 0.040 | 0.056 |
| | | | 0.832 | 0.080 | 0.088 | 0.040 | 0.056 |
| 2........ | 0.384 | 0.224 | 0.504 | 0.048 | 0.072 | 0.040 | 0.056 |
| | | | 0.528 | 0.048 | 0.072 | 0.040 | 0.056 |
| 3........ | 0.448 | 0.336 | 0.736 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.712 | 0.064 | 0.072 | 0.040 | 0.056 |
| 4........ | 0.464 | 0.312 | 0.704 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.744 | 0.064 | 0.064 | 0.040 | 0.056 |

Specimen No. 2 is smaller, has four hairs on cauda instead of three, and is somewhat different in other ways. Since it was taken from the same host, I hesitate to describe it as new until more is known of it.

*Host.*—*Rhododendron rhodora.*

*Distribution.*—Orono, Maine.

*Cotypes.*—Returned to Maine Agricultural Experiment Station.

### AMPHOROPHORA RUBI (Kaltenbach)

Figs. 150–157, and 190

*Aphis rubi* Kaltenbach, Monographie der Pflanzenlause, 1843, p. 24.

*Siphonophora rubi* (Kaltenbach) Koch, Die Pflanzenlause Aphiden, 1854, p. 191.—Buckton, British Aphides, vol. 1, 1876, p. 140.—Thomas, 8th Rept. Ill. St. Ent., 1880, p. 64.—Lichtenstein, Les Pucerous, Monographie des Aphidiens, 1885, p. 40.—Williams, Univ. Nebr. Spec. Bull. 1, 1891, p. 7.—Schouteden, Ann. de la Soc. Ent. Belg., vol. 44, 1900, p. 116.—Williams, Kans. Univ. Studies, vol. 10, no. 2, 1910, p. 84.

*Nectarophora rubi* (Kaltenbach) Oestlund, Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, p. 87.—Hunter, Iowa Agr. Exp. Sta. Bull. 60, pp. 116, 130.

*Macrosiphum rubi* (Kaltenbach) Del Guercio, Nuove Rel. Staz. Firenze, ser. 1, no. 2, 1900, p. 159.—Schouteden, Ann. de la Soc. Ent. Belg., vol. 45, 1901, p. 271.—Sanborn, Kans. Univ. Sci. Bull., vol. 3, no. 8, 1906, pp. 248, 268.—Davis, Journ. Econ. Ent., vol. 4, 1911, p. 329; Nebr. Univ. Studies, Ent., no. 5, 1911, p. 34; Bull. Ill. St. Lab. Nat. Hist., vol. 10, 1913, p. 104.—Wilson and Vickery, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 148.

*Amphorophora rubi* (Kaltenbach) Schouteden, Mem. de la Soc. Ent. de Belg., vol. 12, 1906, p. 242.—Gillette, Journ. Econ. Ent., vol. 4, 1911, p. 381.—Theobald, Ent., vol. 50, 1917, p. 79; Fruit, Flower and Vegetable Trades Journal, London, Oct. 13, 1917.—Shinji, Can. Ent., vol. 49, 1917, p. 52.—Essig, Univ. Cal. Pub. vol. 1, no. 7, 1917, p. 329.—Swain, Univ. Cal. Pub., vol. 3, no. 1, 1919, p. 54.

*Rhopalosiphum rubi* (Kaltenbach) Van der Goot, Beit. kennt. der Holland. Blattlause, 1915, p. 153.—Muller-Thurgau, Osterwalder, Schneider-Orelli, Rept. Dept. Plant Phys. and Plant Path. Swiss Exp. Inst. for Fruit, Vine and Garden Cult. at Wadenswil for the year 1915–16, 1917; Sept. from Landwist schaftl. Jahrbuch der Schweiz, p. 416.

*Eunectarosiphon rubi* (Kaltenbach) Del Guercio, Redia, vol. 9, 1913, p. 188.

*Acrythosiphon* (*Amphorophora*) *rubi rubi* (Kaltenbach) Mordvilko, Fauna de la Russie, 1919, p. 251.

*Nectarosiphon rubi* (Kaltenbach) Patch, Conn. St. Geol. and Nat. Hist. Surv. Bull. 34, 1923, p. 310.

*Siphonophora fragariella* Theobald, Rept. Econ. Zool. year ending Apr. 1, 1905, p. 35.

*Macrosiphum fragariellum* Theobald, Journ. Econ. Biol., vol. 8, no. 3, 1913, p. 124.

*Acyrthosiphon* (*Amphorophora*) *rubi fragariellum* (Theobald) Mordvilko, Fauna de la Russie, 1919, p. 263.

This species seems to be widely distributed in Europe and on the North American continent. In America, however, there is another similar species (see *sensoriata* Mason) which, no doubt, has often been confused with *rubi*. In many of the references in literature it is impossible to tell to which one the writer referred. Gillette had this new species when he wrote: "A very similar species taken by Mr. Bragg at Lawrence, Kans., differs by having cornicles decidedly shorter and having joint 4 of the antenna in the alate viviparae well set with sensoria." Dr. C. P. Gillette kindly lent me this slide for examination. Still another species which might be confused with *rubi* Kaltenbach is described in this paper as *reticulata*, new species.

The typical *rubi* Kaltenbach, as fixed by Gillette, Van der Goot, and Mordvilko and which is accepted here, has sensoria only on segment III, while *sensoriata* Mason has them also on IV and V. Gillette says that specimens from England examined by him are a little smaller but agree in other respects with American specimens.

The species described by Swain in 1919 is not *rubi* Kaltenbach. He described specimens received from Gillette. I have had the privilege of examing these same slides, kindly lent by Ferris, and they prove to be the same as other specimens which I had already described in manuscript as *davidsoni*, new species. Swain did have specimens of *rubi* Kaltenbach from other sources, but did not describe them.

Mordvilko under *rubi* Kaltenbach considers four subspecies. One of these is the typical *rubi* Kaltenbach. Another is *fragariellum* Theobald which I believe to be the same as *rubi* Kaltenbach. The other two subspecies are apparently distinct and I have elevated them to the rank of species. These are discussed under the individual species. I give herewith a translation of Mordvilko's key for the separation of his four subspecies.

1. (6) The third segment of the antennae exceeds the fourth only slightly, for instance, one and one-third to one-seventh times; the unguis of the sixth segment almost equals the third segment (in wingless females somewhat shorter and in winged, somewhat though very little longer).

2. (5) The base of the sixth segment of the antennae consists of one-seventh to one-sixth the length of the third segment, reaching 0.17–0.19 and almost 0.20 mm., but at times (in the case of long antennae) 0.22.

3. (4) The cornicles even in the wingless females are dark, in front of the flange they are usually very slightly but nevertheless noticeably swollen; they reach one-fourth to two-ninths the length of the body (in wingless females); cauda with 3–4 bristly lateral hairs-------- **Ac. rubi amurense**, new subspecies.

4. (3) Cornicles in wingless females light colored; in front of the flange there is hardly any swelling noticeable; the cornicles reach two-sevenths to one-third the length of the body; on the sides of the cauda are 5–6 bristly hairs---------------------------------------- **Ac. rubi rubi** (Kaltenbach).

5 (2) The base of the sixth segment of the antennae consists of one-fifth the length of the third, reaching 0.22 mm------- **Ac. rubi fragariellum** (Theobald).

6. (1) The third segment of the antenna exceeds the fourth distinctly, for instance, one and two-fifths to one and one-half times and the unguis of the sixth segment, even in the wingless females exceeds the third segment distinctly, for instance, one and two-fifths to one and one-half times and the unguis, even in wingless females exceeds the third segment distinctly, for instance, one and two-ninths times; the base of the sixth segment consists of about one-fifth the length of the third reaching 0.17–0.18 mm-------- **Ac. rubi zhuravlevi**, new subspecies.

*Alate viviparous female.*—Large species. General color green. Antennae longer than the body, rather slender, dark colored, hairs nearly as long as width of segment, capitate, more conspicuously so in some specimens, III with 30–50 sensoria over the entire length, not strongly tuberculate. Antennal tubercles very large. Beak reaching second coxae. Prothoracic tubercles large. Cornicles very long, moderately swollen, the tips imbricated but not reticulated. Cauda long, broad, conical, not constricted, with 4–6 sets of lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 1. 104 | 44 | 0. 944 | 0. 816 | 0. 208+1. 200 |
| | 1. 104 | 48 | 0. 960 | 0. 832 | 0. 192+1. 248 |
| 2 | 1. 152 | 40 | 1. 008 | 0. 832 | 0. 200+1. 200 |
| | 1. 136 | 45 | 0. 928 | 0. 832 | 0. 208+1. 232 |
| 3 | 1. 056 | 38 | 0. 960 | 0. 800 | 0. 192+1. 216 |
| | 1. 088 | 33 | 0. 944 | 0. 912 | 0. 192+ ? |
| 4 | 1. 168 | 42 | 0. 848 | 0. 640 | 0. 160+ ? |
| 5 | 1. 168 | 36 | 0. 896 | 0. 688 | 0. 160+1. 136 |
| | 1. 200 | 41 | ? | ? | ? ? |
| 6 | 1. 088 | 32 | 0. 816 | 0. 576 | 0. 144+ ? |
| | 1. 104 | 34 | 0. 800 | 0. 624 | ? |
| 7 | 1. 200 | 31 | 0. 864 | 0. 752 | 0. 176+ ? |
| | 1. 120 | 29 | 0. 704 | 0. 720 | 0. 160+1. 232 |
| 8 | 1. 136 | 30 | 0. 864 | 0. 608 | 0. 160+1. 008 |
| | 1. 072 | 33 | 0. 864 | 0. 624 | 0. 160+ ? |
| 9 | 1. 152 | 42 | 0. 912 | 0. 640 | 0. 160+ ? |
| | 1. 152 | 37 | 0. 880 | 0. 656 | 0. 160+0. 928 |
| 10 | 1. 088 | 37 | 1. 040 | 0. 880 | 0. 208+1. 296 |
| | 1. 056 | ? | 1. 040 | 0. 848 | 0. 192+1. 264 |
| 11 | 1. 088 | 30 | 0. 928 | 0. 768 | 0. 192+1. 280 |
| | 1. 040 | 31 | 0. 880 | 0. 768 | 0. 208+1. 312 |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 560 | 0. 448 | 0. 896 | 0. 088 | 0. 056 | 0. 072 |
| | | | 0. 912 | 0. 088 | 0. 056 | 0. 072 |
| 2 | 0. 528 | 0. 432 | 0. 864 | 0. 088 | 0. 056 | 0. 080 |
| | | | 0. 912 | 0. 096 | 0. 048 | 0. 072 |
| 3 | 0. 528 | 0. 448 | 0. 816 | 0. 088 | 0. 056 | 0. 080 |
| | | | 0. 864 | 0. 096 | 0. 056 | 0. 080 |
| 4 | 0. 560 | ? | 0. 848 | 0. 096 | 0. 056 | 0. 072 |
| | | | 0. 816 | 0. 096 | 0. 056 | 0. 072 |
| 5 | 0. 560 | ? | 0. 880 | 0. 096 | 0. 056 | 0. 072 |
| | | | 0. 864 | 0. 104 | 3. 056 | 0. 072 |
| 6 | 0. 512 | 0. 384 | 0. 768 | 0. 096 | 0. 056 | 0. 072 |
| 7 | 0. 544 | 0. 384 | 0. 800 | 0. 096 | 0. 056 | 0. 072 |
| 8 | 0. 528 | 0. 416 | 0. 800 | 3. 096 | 0. 048 | 0. 064 |
| 9 | ? | 0. 496 | 0. 896 | 0. 104 | 0. 056 | 0. 064 |
| 10 | 0. 544 | 0. 368 | 0. 864 | 0. 088 | 0. 064 | 0. 080 |
| 11 | 0. 544 | 0. 320 | 0. 800 | 0. 088 | 0. 056 | 0. 080 |
| | | | 0. 800 | 0. 080 | 0. 056 | 0. 072 |

*Color Notes by Pergande.*—" The abdomen is greenish, with a darker green median stripe, with a row of 3 to 4 dusky or blackish spots on each side in front of nectaries. Nectaries whitish, their apex black. Tail of color of body. Antennae black, the two basal jts. head, and prothorax yellowish, terminal ⅓ or more of femora, and apex of tibiae and the tarsi black, rest of legs yellowish. Eyes and thoracic lobes brown."

*Apterous viviparous female.*—Large, green. Antennae somewhat longer than body, light colored, becoming darker towards the distal end, imbricated, hairs very conspicuous, nearly as long as width of segment, capitate on some specimens, III with 4–19 sensoria on outer side of basal half. Antennal tubercles very large. Beak reaching beyond second coxae. Prothoracic tubercles present, a hair near each one. No abdominal tubercles showing. Cornicles long, slender, but plainly swollen, tips imbricated, not reticulated. Cauda large, long, conical, not constricted, with about five sets of lateral hairs. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 1. 216 | 10 | 0. 968 | 0. 720 | 0. 168+1. 088 |
| | 1. 264 | 13 | 0. 960 | 0. 760 | 0. 160+ ? |
| 2 | 1. 312 | 19 | 0. 896 | 0. 752 | 0. 192+ ? |
| | 1. 280 | 15 | 0. 944 | 0. 768 | 0. 208+1. 216 |
| 3 | 1. 232 | 9 | 0. 976 | 0. 800 | 0. 176+1. 240 |
| | 1. 240 | 10 | 1. 000 | 0. 784 | 3. 176+1. 216 |
| 4 | 1. 104 | 9 | 0. 976 | 0. 720 | 0. 192+1. 152 |
| | 1. 152 | 10 | 0. 960 | 0. 720 | 0. 176+ ? |
| 5 | 1. 264 | 9 | 1. 040 | 0. 816 | 0. 208+ ? |
| | 1. 232 | 9 | 1. 024 | 0. 768 | 0. 192+1. 200 |
| 6 | 1. 216 | 8 | 0. 896 | 0. 768 | 0. 192+1. 168 |
| | 1. 184 | 9 | 0. 960 | 0. 752 | 0. 200+1. 200 |
| 7 | 1. 232 | 13 | 1. 024 | 0. 856 | 0. 224+1. 328 |
| 8 | 1. 248 | 14 | 1. 024 | 0. 816 | 0. 192+1. 264 |
| | 1. 248 | 12 | 0. 992 | 0. 848 | 0. 192+1. 280 |
| 9 | 1. 184 | 7 | 1. 056 | 0. 896 | 0. 216+1. 200 |
| 10 | 1. 120 | 9 | 0. 768 | 0. 560 | 0. 168+1. 008 |
| | 1. 136 | 7 | 0. 848 | 0. 584 | 0. 144+0. 992 |
| 11 | 1. 056 | 5 | 0. 608 | 0. 480 | 0. 144+ ? |
| | 1. 024 | 4 | 0. 608 | 0. 456 | 0. 144+ ? |
| 12 | 1. 136 | 11 | ? | ? | ? |
| | 1. 152 | 8 | 0. 864 | 0. 648 | 0. 160+ ? |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 584 | 0. 512 | 0. 992 | 0. 096 | 0. 064 | 0. 080 |
| | | | 0. 992 | 0. 096 | 0. 064 | 0. 072 |
| 2 | 0. 600 | 0. 544 | 0. 992 | 0. 096 | 0. 056 | 0. 080 |
| | | | 1. 008 | 0. 096 | 0. 064 | 0. 080 |
| 3 | 0. 544 | 0. 512 | 1. 056 | 0. 096 | 0. 064 | 0. 088 |
| | | | 1. 072 | 0. 096 | 0. 064 | 0. 088 |
| 4 | 0. 584 | 0. 464 | 0. 960 | 0. 096 | 0. 064 | 0. 080 |
| | | | 0. 992 | 0. 088 | 0. 064 | 0. 080 |
| 5 | 0. 608 | 0. 520 | 0. 976 | 0. 104 | 0. 064 | 0. 080 |
| | | | 1. 024 | 0. 104 | 0. 064 | 0. 080 |
| 6 | 0. 544 | 0. 464 | 0. 960 | 0. 088 | 0. 056 | 0. 080 |
| | | | ? | 0. 096 | 0. 064 | 0. 080 |
| 7 | 0. 608 | 0. 496 | 1. 024 | 0. 088 | 0. 056 | 0. 080 |
| | | | 1. 008 | 0. 088 | 0. 056 | 0. 072 |
| 8 | 0. 600 | 0. 528 | 1. 008 | 0. 096 | 0. 064 | 0. 080 |
| | | | 1. 008 | 0. 104 | 0. 064 | 0. 080 |
| 9 | 0. 576 | 0. 496 | 0. 976 | 0. 080 | 0. 048 | 0. 064 |
| | | | 0. 960 | 0. 080 | 0. 056 | 0. 072 |
| 10 | 0. 576 | 0. 480 | 0. 928 | 0. 112 | 0. 064 | 0. 080 |
| | | | 0. 912 | 0. 112 | 0. 056 | 0. 072 |
| 11 | 0. 496 | 0. 464 | 0. 832 | 0. 088 | 0. 056 | 0. 072 |
| 12 | 0. 568 | 0. 480 | 0. 960 | 0. 120 | 0. 064 | 0. 072 |
| | | | 0. 896 | 0. 112 | 0. 064 | 0. 080 |

*Alate male.*—Antennae much longer than body, dark colored, especially III, hairs nearly as long as width of segment, III and V with sensoria, IV without. Beak about reaching second coxae. Cornicles dark colored, long, moderately swollen, tips imbricated. Cauda as seen from the side, is of moderate length, not constricted and with 3 or 4 lateral hairs. Measurements as follows:

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 0.944 | 67 | 0.720 | 0 | 0.736 | 18 | 0.192+1.312 |
| 0.976 | 64 | 0.768 | 0 | 0.712 | 19 | 0.176+ ? |

| Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|
| | | Length | Wide X | Small X | Flange |
| ? | 0.144 | 0.576 | 0.064 | 0.040 | 0.056 |
| | | 0.576 | 0.064 | 0.040 | 0.056 |

*Apterous Oviparous Female.*—This is described by Van der Goot.

*Biology.*—This species is found on probably a large number of the members of the genus *Rubus*, both wild and cultivated. Exact specific records of the host plants are, however, often wanting. So far as known it has no alternate host, and it has been found throughout the summer on *Rubus*.

Pergande found them singly on the under side of leaves. He called attention in his notes to the difference between this and the habits of *sensoriata* Mason, which are found on the canes.

In his account of *fragariellum*, Theobald gives additional biological data.

It is probable that this species is responsible for the spread of mosaic, but there are no definite published data as yet.

Theobald reports it from the dissected crops of young fowls.

*Food Plants.*—*Rubus*, strawberries.

*Distribution.*—Europe, North America (Massachusetts; Maine; Ottawa, Canada; New York; District of Columbia; Virginia; Ohio; Minnesota; Colorado; New Mexico; and California).

*Type.*—Kaltenbach's type is undoubtedly lost. Specimens which I consider to be this species and which agree with descriptions of other authors are in the National Collection.

### AMPHOROPHORA RUBICOLA (Oestlund)

Figs. 144–149, 193

*Macrosiphum rubicola* Oestlund, Minn. St. Geol. Rept. no. 14, 1886, p. 27; Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, p. 78.—Williams, Univ. Nebr. Spec. Bull. 1, 1891, p. 22.—Hunter, Iowa Agr. Exp. Sta. Bull. 60, 1901, p. 110.—Patch, Maine Agr. Exp. Sta. Bull. 233, 1914, p. 270.

*Nectarosiphon rubicola* (Oestlund) Kirkaldy, Canad. Ent., 1906, p. 12.—Sanborn, Kans. Univ. Sci. Bull., vol. 3, no. 8, 1906, p. 269.—Wilson, Ann. Ent. Soc. Amer., vol. 3, 1910, p. 318; Proc. Brit. Colum. Ent. Soc., vol. 5, 1915, p. 83.—Wilson and Vickery, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 149.—Swain, Univ. Cal. Pub. Tech. Bull. Agr. Exp. Sta. Ent., vol. 3, no. 1, 1919, p. 77.—Patch, Conn. St. Geol. and Nat. Hist. Surv. Bull., no. 34, 1923, p. 310.

*Nectarosiphum rubicola* (Oestlund) Essig, Univ. Cal. Pub. Tech. Bull. Agr. Exp. Sta. Ent., vol. 1, no. 7, 1917, p. 327.—Shinji, Psyche, vol. 24, no. 3, 1917, p. 84.

*Amphorophora rubicola* (Oestlund) Davidson, Journ. Econ. Ent., 1914, p. 136.

This large species on *Rubus* is rather close in appearance to two other species on *Rubus* which are described in this paper as *davidsoni* and *maxima*. It may be distinguished from them by the large dusky spot on the tips of the wings and by the dark colored antennae, segment III of which is conspicuously shorter than the cornicle and has 20–30 sensoria.

*Alate viviparous female.*—Antennae about as long as body, dark colored, except base of III, hairs conspicuous, about as long as width of segment, III with 20–30 sensoria scattered over nearly the entire length and not in a straight row. Antennal tubercles fairly large. Beak extending usually to third coxae. In some specimens there are two tubercles showing on the posterior, dorsal portion of the head. The prothorax has two dorsal tubercles, and a lateral tubercle on each side. The front wings have a dusky spot at the tips. This is darker in some specimens than in others. The abdomen has several lateral tubercles, one specimen showing five in front of the cornicle and one caudad of the cornicle. Hairs are present around each tubercle. The cornicles are long, curved, conspicuously swollen and distinctly reticulated. The cauda is long, slender and constricted, with 5–6 lateral hairs.

*Antennal measurements*

| No. | III | Sensoria on III | | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 896 | 26 | 0. 592 | 0. 560 | 0. 112+(0. 592+) |
| | 0. 864 | 25 | 0. 608 | 0. 528 | 0. 112+(0. 496+) |
| 2 | 0. 928 | 23 | ? | ? | ? |
| | 0. 960 | 22 | 0. 832 | 0. 784 | 0. 160+1. 008 |
| 3 | 0. 848 | 27 | 0. 576 | 0. 512 | 0. 152+0. 928 |
| | 0. 848 | 28 | ? | ? | ? |
| 4 | 0. 992 | 30 | 0. 656 | 0. 576 | 0. 152+0. 880 |
| | 0. 976 | 22 | 0. 688 | 0. 576 | 0. 144+0. 880 |
| 5 | 0. 848 | 21 | 0. 576 | 0. 480 | 0. 128+0. 816 |
| | 0. 832 | ? | 0. 592 | 0. 480 | 0. 128+0. 864 |

*Other measurements*

| No. | Head | Cauda | Cornicle |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 560 | 0. 304+ | 1. 024 | 0. 080 | 0. 192 | 0. 072 | 0. 088 |
|  |  |  | 1. 040 | 0. 080 | 0. 192 | 0. 072 | 0. 088 |
| 2 | 0. 544 | 0. 320+ | 1. 312 | 0. 080 | 0. 156 | 0. 064 | 0. 088 |
|  |  |  | 1. 280 | 0. 096 | 0. 144 | 0. 064 | 0. 080 |
| 3 | 0. 544 | 0. 336 | 1. 184 | 0. 080 | 0. 160 | 0. 064 | 0. 080 |
|  |  |  | 1. 184 | 0. 080 | 0. 176 | 0. 064 | 0. 080 |
| 4 | 0. 512 | 0. 448 | 1. 136 | 0. 096 | 0. 120 | 0. 064 | 0. 080 |
|  |  |  | 1. 120 | 0. 080 | 0. 120 | 0. 064 | 0. 080 |
| 5 | 0. 512 | 0. 368 | 1. 152 | 0. 080 | 0. 152 | 0. 064 | 0. 080 |
|  |  |  | 1. 200 | 0. 048 | 0. 192 | 0. 064 | 0. 080 |

Patch gives the most compact color description, although it is taken from a rather dark specimen.

*Apterous viviparous female.*—Antennae about as long as body, light colored except distal ends of segments and VI, hairs numerous, about as long as width of segment, III with 13–15 sensoria on basal half. Beak reaching nearly to third coxae. The only tubercles showing are the lateral prothoracic ones. Cornicles very long, not as conspicuously reticulated as in the alates, somewhat imbricated. Cauda small, somewhat constricted. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 944 | 14 | 0. 544 | 0. 480 | 0. 112+0. 848 |
|  | 0. 944 | 15 | 0. 560 | 0. 432 | 0. 112+ ? |
| 2 | 0. 768 | 13 | 0. 560 | 0. 512 | 0. 128+0. 944 |
|  | 0. 864 | 13 | ? | ? | ? |

| No. | Head | Cornicle |  |  |  |  |
|---|---|---|---|---|---|---|
|  |  | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 528 | 1. 424 | 0. 032 | 0. 144 | 0. 064 | 0. 080 |
|  |  | 1. 392 | 0. 048 | 0. 152 | 0. 064 | 0. 072 |
| 2 | 0. 528 | 1. 120 | 0. 032 | 0. 128 | 0. 064 | 0. 072 |
|  |  | 1. 200 | ? | 0. 128 | 0. 064 | 0. 072 |

Pergande left the following color description of metatype apterous specimens, taken on *Rubus strigosus* at Minneapolis, Minn., July 14, 1903: "Color greenish yellow, marked with a broad dark green median and lateral stripe. Eyes dark brown; nectaries stout and dusky. Antennae whitish; apex of jts. 3–5 and the last black femora pale bluish green; tibiae pale yellowish, darkest toward the end, tarsi black. Head yellowish, tail greenish, body not or but faintly pruinous."

*Alate male.*—Only one specimen is available for study, and this specimen has lost one antenna and all but a part of segment III of the other. This portion is 0.704 mm. long, dark colored, lighter at the base, thickly covered with 57 circular sensoria, hairs almost as long as width of segment. Antennal tubercles not large. Head 0.496 mm. across eyes. No tubercles showing on thorax or abdomen. Tips of wings with dusky spot. Abdomen light colored. Cornicles light colored, reticulated at the tips, imbricated over the entire length, measurements as follows:

| Length | Reticulated | Wide X | Small X | Flange |
|---|---|---|---|---|
| 0. 768 mm. | 0. 064 | 0. 104 | 0. 048 | 0. 064 |
| 0. 752 | 0. 064 | 0. 104 | 0. 056 | 0. 064 |

*Oviparous females.*—Light colored. Antennae light colored, about equal to the body in length, hairs conspicuous, nearly as long as width of segment, with a group of sensoria near base of III. Antennal tubercles of moderate length. Beak reaching to third coxae. Cornicles light colored, darker at the tips, reticulated. Cauda conical, not constricted, with three sets of lateral hairs. Posterior tibiae with numerous sensoria on basal half, becoming less numerous on distal half. Measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 672 | 5 | 0. 432 | 0. 400 | 0. 120+0. 672 |
|  | 0. 672 | 5 | 0. 424 | 0. 408 | 0. 136+ ? |
| 2 | 0. 704 | 6 | 0. 496 | 0. 432 | 0. 120+0. 688 |
|  | 0. 752 | 10 | 0. 480 | 0. 400 | 0. 112+0. 688 |
| 3 | 0. 688 | 7 | 0. 448 | 0. 400 | 0. 120+0. 672 |
|  | 0. 720 | 9 | 0. 480 | 0. 368 | ? |
| 4 | 0. 736 | 11 | 0. 496 | 0. 416 | 0. 112+0. 720 |
|  | ? | ? | ? | 0. 416 | 0. 120+0. 720 |

| No. | Width of head | Cauda | Cornicle |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 512 | 0. 208 | 0. 944 | 0. 064 | 0. 176 | 0. 064 | 0. 080 |
|  |  |  | 0. 992 | 0. 064 | ? | 0. 064 | 0. 080 |
| 2 | 0. 512 | 0. 176 | 1. 008 | 0. 064 | 0. 168 | 0. 064 | 0. 080 |
|  |  |  | 0. 960 | 0. 064 | 0. 160 | 0. 064 | 0. 080 |
| 3 | 0. 528 | ? | 0. 976 | 0. 064 | 0. 120 | 0. 064 | 0. 080 |
|  |  |  | ? | ? | ? | ? | ? |
| 4 | 0. 520 | 0. 240 | 0. 912 | 0. 064 | ? | 0. 064 | 0. 080 |
|  |  |  | 1. 040 | 0. 080 | 0. 112 | 0. 064 | 0. 080 |

The alate male and oviparous females just described were taken by Dr. A. C. Baker on wild raspberry. No viviparous forms were taken, but I feel certain that the specimens must belong to this species.

*Biology.*—But little is known of the biology of this species. It is found on the leaves and shoots of various species of *Rubus.* Dr. Edith M. Patch took an alate female with eight nymphs on wild red raspberry on August 1, 1906, in Maine. In Minnesota Pergande took apterous females and nymphs on July 14, 1903. In California Shinji took alate and apterous viviparous females on March 20, 1915, at Berkeley; Essig found them at the same place on March 29, 1916, at which time "there were also a number of young pink forms not observed during the summer"; he also found the species abundant on May 24, 1916; Davidson took them in the hilly canyons of Contra Costa County, on May 13, 1913—"at that date about 95 per cent of the lice were large pupae or recently transformed adults." Ross took alate and apterous forms at Ottawa, Canada on July 21, 1917, and Wilson at Vancouver, British Columbia, on July 12, 1915.

Shinji took his males at Berkeley, Calif., on April 4, 1915. Oestlund found them in Minnesota "as late as November first, together with the oviparous wingless females." Baker took the sexes described above at Guelph, Ontario, October 10, 1910.

*Distribution.*—From Maine to California; Ottawa and British Columbia.

*Host.*—*Rubus.*

*Cotype.*—Oestlund's collection.

### AMPHOROPHORA SENSORIATA Mason

Figs. 158–163

*Amphorophora sensoriata* MASON, Proc. Ent. Soc. Wash., vol. 25, No. 9, 1923, p. 188.

As explained under *rubi* Kaltenbach, this is the species mentioned by Gillette as differing from *rubi.* It seems to be rather common on this continent and has no doubt often been confused with *rubi.* So far as I know, it is not found in Europe, the type continent of *rubi* Kaltenbach.

It is easily distinguished from *rubi* by the sensoria on IV and V of the alate, by the larger number of sensoria on III in both the alate and apterous forms, by the shorter hairs on the antenna, by the shorter cornicles, and by the smaller number of hairs on the cauda.

*Alate viviparous female.*—Large species. General color green. Antennae longer than body, dark colored, imbricated, hairs inconspicuous, much smaller than in *rubi,* numerous sensoria on III, IV, and some on V. Antennal tubercles large. Beak very short, in

some specimens not reaching second coxae. Prothoracic and abdominal tubercles not showing. Cornicles fairly long, moderately swollen, the tips imbricated, but not reticulated. Cauda of medium length, broad, not constricted, with about three sets of lateral hairs. Measurements as follows:

The first three are from cotype slides, the others from paracotype slides.

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1 | 1. 088 | 75 | 0. 800 | 39 | 0. 576 | 5 | 0. 192+0. 960 |
| | 1. 104 | 82 | 0. 848 | 47 | 0. 560 | 3 | 0. 192+0. 960 |
| 2 | 1. 072 | 62 | 0. 936 | 30 | 0. 512 | 4 | 0. 176+0. 960 |
| | 1. 024 | 62 | 0. 800 | 34 | 0. 544 | 5 | 0. 176+0. 928 |
| 3 | 1. 176 | 65 | 0. 896 | 32 | 0. 608 | 1 | 0. 192+ ? |
| | 1. 184 | 66 | 0. 848 | 38 | 0. 640 | 2 | 0. 192+1. 040 |
| 4 | 1. 040 | 61 | 0. 784 | 32 | 0. 544 | 0 | 0. 176+0. 928 |
| | 1. 120 | 69 | 0. 864 | 36 | ? | ? | ? |
| 5 | 1. 040 | 62 | 0. 768 | 36 | 0. 544 | 0 | 0. 176+1. 040 |
| 6 | 0. 960 | 55 | 0. 736 | 31 | 0. 528 | 5 | 0. 160+0. 928 |
| 7 | 1. 040 | 59 | 0. 672 | 20 | 0. 496 | 3 | 0. 160+0. 880 |
| 8 | 1. 008 | 62 | 0. 784 | 31 | 0. 480 | 4 | 0. 160+0. 800 |
| 9 | 1. 008 | 49 | 0. 768 | 33 | 0. 496 | 5 | 0. 176+ ? |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 536 | 0. 288 | 0. 544 | 0. 072 | 0. 040 | 0. 048 |
| | | | 0. 560 | 0. 072 | 0. 040 | 0. 048 |
| 2 | 0. 528 | 0. 272 | 0. 480 | 0. 072 | 0. 040 | 0. 048 |
| | | | 0. 512 | 0. 072 | 0. 040 | 0. 048 |
| 3 | 0. 544 | 0. 256 | 0. 528 | 0. 072 | 0. 040 | 0. 048 |
| | | | 0. 512 | 0. 080 | 0. 048 | 0. 056 |
| 4 | 0. 528 | 0. 272 | 0. 576 | 0. 072 | 0. 040 | 0. 048 |
| | | | 0. 576 | 0. 072 | 0. 040 | 0. 048 |
| 5 | 0. 512 | 0. 288 | 0. 560 | 0. 080 | 0. 040 | 0. 048 |
| 6 | 0. 480 | ? | 0. 496 | 0. 072 | 0. 040 | 0. 048 |
| 7 | 0. 512 | 0. 240 | 0. 512 | 0. 072 | 0. 040 | 0. 048 |
| 8 | 0. 504 | 0. 272 | 0. 560 | 0. 072 | 0. 040 | 0. 048 |
| 9 | 0. 544 | 0. 288 | 0. 608 | 0. 072 | 0. 040 | 0. 048 |

The following color notes were made by Pergande from the cotype specimens:

"Color of abdomen of migrant light to dark bluish green and highly polished; head and thoracic and sternal plate yellowish brown, the sutures of the lobes more or less black; disk of prothorax very pale brownish, darkest along its posterior margin; eyes reddish brown; ocelli bordered with black at inner margin; antenna black; legs black, the femora brownish yellow at base; nectaries black, greenish at base; tail greenish, or yellowish green; wings colorless, subcosta brown or yellowish brown, stigma dusky, veins black, those of stigmal vein and branches of third slighly clouded at tip."

*Apterous viviparous female.*—Antennae about a third longer than body, imbricated, the hairs inconspicuous, much shorter than width of segment, III with a row of sensoria. Antennal tubercles large. Beak reaching about to second coxae. Cornicles moderately long, plainly swollen, the tips imbricated, but not reticulated. The cauda broad, conical, not constricted, with about three sets of lateral hairs. Measurements as follows:

No. 1 is from the cotype slide. Other are paracotypes.

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 1. 088 | ? | 0. 864 | 0. 608 | 0. 162+0. 992 |
| 2 | 1. 088 | 32 | 0. 864 | 0. 576 | 0. 192+ ? |
| 3 | 1. 152 | 34 | 0. 864 | 0. 592 | 0. 176+ ? |
| 4 | 1. 088 | 30 | 0. 704 | 0. 480 | 0. 176+0. 760 |
| 5 | 1. 104 | 23 | 0. 816 | ? | ? |

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0. 536 | ? | 0. 608 | 0. 072 | 0. 040 | 0. 048 |
| 2 | 0. 544 | 0. 352 | 0. 608 | 0. 088 | 0. 040 | 0. 048 |
| 3 | 0. 544 | 0. 288 | 0. 592 | 0. 088 | 0. 040 | 0. 048 |
| 4 | 0. 528 | 0. 256 | 0. 576 | 0. 080 | 0. 040 | 0. 048 |
| 5 | 0. 496 | 0. 256 | 0. 608 | 0. 080 | 0. 040 | 0. 048 |

Pergande left the following color notes of the cotype specimen: "Apterous female pale bluish green; antennae black, the two basal joints and front edge of head brownish yellow, eyes brown, legs yellowish brown, the base of femora very pale bluish green; nectaries dusky, paler at base, tail of color of body."

*Intermediate.*—Similar to other forms, except for very small wings, larger on left side, and for the number of sensoria, III have 37 on one side and 39 on the other, IV having 5 on each antenna. No ocelli present. Measurements as follows:

| III | IV | V | VI |
|---|---|---|---|
| 1. 152 | 0. 912 | 0. 560 | 0. 192+0. 896 |
| 1. 152 | 0. 848 | 0. 544 | 0. 192+0. 720 |

| Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|
| | | Length | Wide X | Small X | Flange |
| 0. 496 | 0. 336 | 0. 640 | 0. 080 | 0. 040 | 0. 048 |

*Biology.*—I have found this species sparingly on the stems of raspberry, never on the leaves. Pergande says in his notes: "Found on stems of *Rubus*, which they sometimes covered for a distance of several inches. Drop readily, if disturbed." It probably remains on *Rubus* throughout the year. I have examined specimens taken June 26, 1903, in Virginia (type); July 11, 1903, Minnesota; June 20, 1905, District of Columbia; July 10, 1919, West Virginia; June 20, 1920, Pennsylvania; September 20, 1921, Maryland; and September 13, Massachusetts.

*Distribution.*—Massachusetts, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, Ohio, Minnesota, and Kansas.

*Host.*—*Rubus.*

*Cotypes.*—Deposited in U. S. National Museum. Cat. No. 26379. Paracotype slides in the National Museum and in the collection of Dr. T. L. Guyton.

### AMPHOROPHORA SOLANI (Thomas)

Figs. 10–13

*Megoura solani* THOMAS, Rept. Ill. State Ent., vol. 8, 1880, p. 73.—LICHTENSTEIN, Monographie des Aphidiens, 1885, p. 41.—ASHMEAD, Bull. Div. Ent. U. S. Dept. Agr. 14, 1887, p. 18.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 158.

*Rhopalosiphum solani* (Thomas) OESTLUND, Rept. Minn. St. Geol., vol. 14, 1885, p. 29; Minn. Geol. and Nat. Hist. Surv. Bull. 4, 1887, p. 76.—HUNTER, Iowa Agr. Exp. Sta. Bull. 60, 1901, p. 107.—DAVIS, Journ. Econ. Ent., vol. 3, 1910, p. 495; Bull. Ill. St. Lab. Nat. Hist., vol. 10, 1913. p. 100.

*Myzoides persicae* (Sulzer) VAN DER GOOT, Beit. zur Kennt. der Hollandischen Blattlause, 1915, p. 170.

This species is not known to me. It was first taken by Thomas at Carbondale, Ill., on May 26, 1878, and described by him in 1880.

In 1913 Davis redescribed it from specimens in the Illinois collection, which he considered to be the type specimens and gave camera lucida drawings. These appear to be of a valid species of *Amphorophora.*

Ashmead[6] discusses a tomato aphis under this name, but I am not certain that he had the same species.

*Host plant.*—Tomato.

*Distribution.*—Illinois.

*Type.*—Deposited in collection of Illinois State Laboratory of Natural History.

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[6] U. S. Div. Ent. Bull. 14, 1887, pp. 18–19.

### AMPHOROPHORA SPIRAECOLA (Patch)

Figs. 164–168

*Macrosiphum spiraecola* PATCH, Maine Agr. Exp. Sta. Bull. 233, 1914, p. 271.—WILSON and VICKERY, Trans. Wis. Acad. Sci. Arts and Letters, vol. 19, pt. 1, 1918, p. 161.

*Nectarosiphon spiraecola* PATCH, Conn. Geol. and Nat. Hist. Surv. Bull. 34, 1923, p. 310.

The writer has had the privilege of examining the cotype specimens which were kindly lent by Dr. Edith M. Patch. In the original account only the apterous form was discussed. Doctor Patch later took a single alate viviparous female in company with apterous forms. The drawings and the following description are from this specimen.

*Alate viviparous female.*—Antennae nearly twice as long as body, rather slender, dark colored, length of hairs less than half of diameter of the segment, III with 15–17 circular sensoria of varying sizes and not in an even row, IV, V, and VI distinctly inbricated and with no secondary sensoria; length of segments as follows:

| III | IV | V | VI |
|---|---|---|---|
| 0. 896 mm.<br>0. 848 | 0. 816<br>0. 848 | 0. 880<br>0. 896 | 0. 224+1. 312<br>0. 224+1. 280 |

The specimen which lays on its side shows a tubercle slightly back of the center of the head, with a knobbed hair directly in front of it. The antennal tubercles appear rather small from the lateral view. The beak is short, not reaching beyond the second coxae. The cornicles are moderately swollen, 0.784 mm. long, reticulated for 0.08 mm., imbricated over nearly the entire length, widest diameter 0.12 mm., smallest diameter 0.048 mm., flange 0.064 mm. wide. The cauda is twisted, but appears to be very long and moderately wide.

Doctor Patch, in a letter furnishes the following color notes: "Thorax pale brown; body pale brown; cornicle pale, tip dark."

*Apterous viviparous female.*—Antennae about twice as long as body, lighter colored than in the alate, hairs inconspicuous, shorter than width of segment, III with 3–7 sensoria near base, distal segments faintly imbricated. Antennal tubercles large and conspicuous.

Beak reaching second coxae. Cornicles long, moderately swollen, distinctly reticulate at tip. Cauda long, conical, slight indication of constriction, three sets of hairs.

*Antennal measurements*

| III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|
| 1. 088 | 3 | 0. 880 | 0. 816 | 0. 192+1. 120 |
| 1. 088 | 5 | 0. 880 | 0. 832 | 0. 192+1. 088 |
| 0. 992 | 3 | 0. 912 | 0. 848 | 0. 208+(0. 736+) |
| 0. 976 | 4 | 0. 880 | 0. 880 | 0. 208+1. 120 |
| 0. 992 | 7 | 0. 880 | 0. 848 | 0. 208+1. 264 |
| 0. 992 | 6 | 0. 848 | 0. 816 | 0. 208+1. 232 |
| 1. 088 | 5 | 0. 912 | 0. 840 | 0. 208+1. 168 |
| 1. 056 | 6 | 0. 912 | 0. 880 | 0. 208+1. 200 |
| 0. 864 | 3 | 0. 816 | 0. 800 | 0. 224+1. 152 |
| 0. 944 | 3 | 0. 800 | 0. 816 | 0. 208+1. 152 |
| 0. 784 | 3 | 0. 736 | 0. 608 | 0. 176+1. 040 |
| 0. 784 | ? | 0. 704 | 0. 592 | 0. 192+1. 232 |

*Other measurements*

| Head width | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|
| | | Length | Reticulated | Wide X | Small X | Flange |
| 0. 480 | 0. 480 | 0. 976 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| | | 0. 976 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| 0. 480 | 0. 400 | 0. 864 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| | | 0. 928 | 0. 064 | 0. 088 | 0. 048 | 0. 064 |
| 0. 464 | 0. 448 | 0. 896 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| | | 0. 896 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| 0. 536 | 0. 480 | 1. 008 | 0. 064 | 0. 096 | 0. 056 | 0. 072 |
| | | 0. 992 | 0. 064 | 0. 096 | 0. 056 | 0. 072 |
| 0. 496 | 0. 416 | 1. 024 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| | | 0. 912 | 0. 064 | 0. 080 | 0. 048 | 0. 064 |
| | 0. 416 | 0. 960 | 0. 064 | 0. 080 | 0. 056 | 0. 064 |
| | | 0. 960 | 0. 064 | 0. 080 | 0. 048 | 0. 072 |
| 0. 480 | 0. 416 | 0. 752 | 0. 064 | 0. 064 | 0. 048 | 0. 064 |
| | | 0. 768 | 0. 064 | 0. 072 | 0. 048 | 0. 056 |

This species was first taken by Doctor Patch on August 20, 1910, on the ventral side of the leaves of *Spiraea van houttei* at Orono, Me. The collection consisted of apterous viviparous females and nymphs. On July 11, 1916, she took a single alate female with young, and apterous females with young on *Spiraea salicifolia* at Orono, Me. There is in the National Museum a single slide containing two apterous viviparous females. These were taken by A. N. Caudell at Kaslo, British Columbia, June 23, 1903, on *Spiraea* species. I know of no other collections.

*Cotypes.*—Deposited in the collection of the Maine Agricultural Experiment Station—apterous No. 97-10, alate No. 84-16.

### AMPHOROPHORA TAKAHASHII, new species

Figs. 78, 79

*Amphorophora*, species TAKAHASHI, Aphididae of Formosa, pt. 2, Report No. 4, Dept. of Agr., Government Research Institute, Formosa, Japan, 1923, p. 32.

Takahashi discusses this form without giving it a name, simply calling it *Amphorophora*, species. While I have not seen it, I do not recognize it from his description as belonging to any of the named species in this genus. It is evidently a border line species between *Amphorophora* and *Macrosiphum*. I take pleasure in naming it after Takahashi and quote his description.

> *Wingless viviparous female.*—White, somewhat pale yellowish. Eyes black. Antennae white, apices of the third, fourth, and fifth joints, and the sixth black. Cornicles white with black apices. Legs white, apical halves of femora, apices of tibiae, and tarsi black; tibiae somewhat pale brownish on the basal half. Cauda white. Body oval, with some short bristles. Frontal tubercles large, somewhat convex on the inner side. Antennae very long and slender, provided with a few short hairs; the third joint provided with one or two small circular sensoria near the base; the fourth very slightly imbricated, lacking sensoria; the relative length of joints as follows: III–75, IV–53, V–48, VI–115 (18+97). Rostrum reaching beyond the hind coxae. Cornicles long, a little longer than the fourth antennal joint, about 1.8 times as long as the cauda, cylindrical, very slightly dilated about the middle and on the base, with a little imbrication at the tip. Cauda large, ensiform, with a few lateral bristles. Legs very long and slender; tibiae provided with many short bristles; tarsi rather short.
>
> Length of body, 2.1 mm. Antennae, about 3.2 mm. Cornicle, 0.6 mm.
>
> *Host.*—*Pollia japonica*, attacking the leaf.
>
> *Distribution.*—Formosa; Rimogan near Urai.
>
> Collected by Messrs. Kurosawa and Sueta in July, 1921.

*Cotype.*—Specimens in the Entomological Laboratory of the Department of Agriculture Government Research Institute, Formosa.

### AMPHOROPHORA VACCINII, new species

Figs. 179–188, 191–192

*Alate viviparous female.*—Antennae about twice as long as body, dark colored, imbrications not conspicuous, hairs small and inconspicuous, III with a row of 12–16 circular sensoria on outer edge, other segments without secondary sensoria. Antennal measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0.720 | 15 | 0.608 | 0.576 | 0.160+0.896 |
|  | 0.688 | 16 | 0.624 | 0.592 | 0.176+0.784 |
| 2 | 0.704 | 14 | 0.560 | 0.544 | 0.176+0.896 |
|  | 0.688 | 12 | 0.560 | 0.566 | 0.176+ ? |

Antennal tubercles large and distinct. Beak reaching about to second coxae. Cornicles light at base, remainder darker, long and slender, plainly swollen, somewhat imbricated, distinctly reticulated at tip. Cauda light colored, long and slender, only slightly constricted, with three sets of lateral hairs.

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0. 44 | 0. 464 | 0. 688 | 0. 096 | 0. 072 | 0. 040 | 0. 064 |
| | | | 0. 688 | 0. 112 | 0. 072 | 0. 040 | 0. 056 |
| 2 | 0. 40 | ? | 0. 688 | 0. 096 | 0. 064 | 0. 040 | 0. 056 |
| | | | 0. 672 | 0. 096 | 0. 064 | 0. 040 | 0. 056 |

*Apterous viviparous female.*—Antennae about twice as long as body, somewhat lighter in color than in the alates, imbrications not conspicuous, hairs very small and inconspicuous, a row of 2–4 sensoria near base of III. Antennal measurements as follows:

| No. | III | Sensoria on III | IV | V | VI |
|---|---|---|---|---|---|
| 1 | 0. 672 | 3 | 0. 512 | 0. 480 | 0. 160+0. 816 |
| | 0. 672 | 2 | 0. 512 | 0. 480 | 0. 160+0. 864 |
| 2 | 0. 704 | 4 | 0. 528 | 0. 496 | 0. 176+0. 896 |
| | 0. 736 | 4 | 0. 528 | 0. 512 | 0. 160+0. 896 |
| 3 | 0. 768 | 4 | 0. 608 | 0. 608 | 0. 176+0. 880 |
| 4 | 0. 704 | 4 | 0. 496 | 0. 496 | 0. 144+0. 800 |
| | 0. 688 | 4 | 0. 512 | 0. 504 | 0. 160+0. 784 |
| 5 | 0. 624 | 3 | 0. 480 | 0. 464 | 0. 160+0. 816 |
| | 0. 640 | 3 | 0. 480 | 0. 480 | 0. 144+0. 960 |
| 6 | 0. 672 | 2 | 0. 528 | 0. 560 | 0. 176+0. 832 |
| | 0. 672 | 3 | 0. 544 | 0. 544 | 0. 176+0. 880 |
| 7 | 0. 672 | 3 | 0. 496 | 0. 512 | 0. 176+0. 832 |
| 8 | 0. 640 | 2 | 0. 448 | 0. 464 | 0. 160+0. 816 |
| | 0. 640 | 2 | 0. 480 | 0. 496 | 0. 176+0. 848 |
| 9 | 0. 672 | 3 | 0. 496 | 0. 496 | 0. 160+0. 752 |
| | 0. 688 | 3 | 0. 512 | 0. 496 | 0. 160+0. 752 |
| 10G | 0. 800 | 2 | 0. 576 | 0. 656 | 0. 208+1. 408 |
| | 0. 784 | ? | 0. 624 | 0. 672 | 0. 208+1. 216 |
| 11G | 0. 752 | 2 | 0. 656 | 0. 688 | 0. 192+1. 216 |
| | 0. 752 | 2 | 0. 656 | 0. 704 | 0. 192+1. 104 |
| 12G | 0. 768 | 2 | 0. 656 | 0. 688 | 0. 176+1. 152 |
| | 0. 768 | 2 | 0. 640 | 0. 672 | 0. 192+1. 120 |
| 13G | 0. 688 | 4 | 0. 544 | 0. 512 | 0. 176+0. 848 |
| | 0. 688 | 3 | 0. 560 | 0. 512 | 0. 176+0. 848 |
| 14G | 0. 640 | 3 | 0. 512 | 0. 528 | 0. 160+0. 864 |
| | 0. 640 | 2 | 0. 512 | 0. 512 | 0. 176+0. 848 |
| | 0. 624 | 4 | 0. 432 | 0. 448 | 0. 176+0. 912 |
| 15G | 0. 608 | 4 | 0. 448 | 0. 448 | 0. 176+0. 912 |

Antennal tubercles very large and distinct. Beak reaching beyond second coxae. Cornicles long, slender, somewhat swollen, plainly reticulated at tip, swollen portion imbricated. Cauda long, slender, not distinctly constricted, three sets of lateral hairs.

Measurements as follows:

| No. | Head | Cauda | Cornicles | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulations | Wide X | Small X | Flange |
| 1 | 0.408 | ? | 0.624 | 0.064 | 0.056 | 0.040 | 0.048 |
| | | | 0.640 | 0.064 | 0.056 | 0.040 | 0.056 |
| 2 | ? | 0.352 | 0.704 | 0.080 | 0.064 | 0.040 | 0.056 |
| | | | 0.704 | 0.080 | 0.064 | 0.040 | 0.056 |
| 3 | 0.432 | 0.368 | 0.880 | 0.112 | 0.072 | 0.048 | 0.056 |
| | | | 0.896 | 0.104 | 0.072 | 0.040 | 0.056 |
| 4 | 0.416 | 0.304 | 0.672 | 0.080 | 0.064 | 0.040 | 0.056 |
| | | | 0.704 | 0.096 | 0.064 | 0.040 | 0.056 |
| 5 | 0.416 | 0.320 | 0.656 | 0.080 | 0.064 | 0.040 | 0.056 |
| | | | 0.672 | 0.080 | 0.064 | 0.040 | 0.056 |
| 6 | 0.416 | 0.296 | 0.720 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.704 | 0.080 | 0.064 | 0.040 | 0.056 |
| 7 | 0.400 | 0.272 | 0.608 | 0.080 | 0.056 | 0.040 | 0.056 |
| | | | 0.656 | 0.080 | 0.056 | 0.040 | 0.056 |
| 8 | 0.400 | 0.304 | 0.752 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.752 | 0.080 | 0.072 | 0.040 | 0.064 |
| 9 | 0.408 | 0.304 | 0.720 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.704 | 0.080 | 0.072 | 0.040 | 0.064 |
| 10G | 0.448 | 0.336 | 0.720 | 0.096 | 0.064 | 0.040 | 0.056 |
| | | | 0.720 | 0.096 | 0.072 | 0.040 | 0.056 |
| 11G | 0.448 | 0.320 | 0.720 | 0.080 | 0.064 | 0.040 | 0.056 |
| | | | 0.704 | 0.080 | 0.064 | 0.040 | 0.056 |
| 12G | 0.392 | 0.304 | 0.704 | 0.080 | 0.072 | 0.040 | 0.056 |
| | | | 0.704 | 0.080 | 0.072 | 0.040 | 0.056 |
| 13G | 0.416 | ? | 0.688 | 0.080 | 0.064 | 0.040 | 0.056 |
| | | | 0.688 | 0.080 | 0.064 | 0.040 | 0.056 |
| 14G | 0.384 | ? | 0.560 | 0.080 | 0.056 | 0.040 | 0.064 |
| | | | 0.560 | 0.064 | 0.056 | 0.040 | 0.056 |
| 15G | 0.376 | 0.232 | 0.512 | 0.048 | ? | ? | ? |
| | | | 0.496 | 0.064 | 0.056 | 0.040 | 0.056 |

*Apterous nymphal measurements*

| Head | Cornicle | III | IV | V | VI |
|---|---|---|---|---|---|
| 0.352 | 0.368 | 0.240 | 0.208 | 0.288 | 0.096+0.592 |
| | 0.368 | 0.240 | 0.208 | 0.272 | 0.112+0.592 |
| 0.360 | 0.384 | 0.232 | 0.208 | 0.256 | 0.112+0.568 |
| | ? | 0.240 | 0.208 | 0.280 | 0.120+ ? |
| 0.416 | 0.560 | 0.480 | 0.528 | 0.528 | 0.160+1.008 |
| | 0.560 | 0.480 | 0.512 | 0.520 | 0.152+1.008 |
| ? | 0.560 | 0.432 | 0.384 | 0.416 | 0.144+0.736 |
| | 0.560 | 0.448 | 0.384 | 0.400 | 0.128+0.752 |

*Apterous oviparous female.*—Antennae about one-third longer than body, light colored (in balsam mount), imbrications not conspicuous, hairs small, shorter than width of segment, III with one to three circular sensoria near base. Antennal measurements as follows:

| No. | III | IV | V | VI |
|---|---|---|---|---|
| 1 | 0.720 | 0.608 | 0.608 | 0.160+0.928 |
| | 0.736 | 0.608 | 0.608 | 0.160+0.912 |
| 2 | 0.640 | 0.592 | 0.560 | 0.184+0.848 |
| | 0.640 | 0.608 | 0.560 | 0.184+0.864 |
| 3 | 0.592 | 0.528 | 0.544 | 0.176+ ? |
| | 0.592 | 0.544 | 0.560 | 0.176+0.864 |

Antennal tubercles large and prominent. Beak reaching second coxae. Hind tibiae with usual sensoria present, more numerous in center than at ends. Cornicles long and slender, only slightly swollen, distinctly reticulated at tip. Cauda conical, not constricted, with three sets of lateral hairs. Measurements as follows:

| No. | Head | Cauda | Cornicle | | | | |
|---|---|---|---|---|---|---|---|
| | | | Length | Reticulated | Wide X | Small X | Flange |
| 1 | 0.448 | 0.304 | 0.656 | 0.064 | 0.064 | 0.048 | 0.064 |
| | | | 0.672 | 0.064 | 0.064 | 0.048 | 0.064 |
| 2 | 0.432 | 0.296 | 0.704 | 0.048 | 0.064 | 0.048 | 0.064 |
| | | | 0.704 | 0.048 | 0.064 | 0.048 | 0.064 |
| 3 | 0.424 | 0.304 | 0.640 | 0.048 | 0.048 | 0.040 | 0.056 |
| | | | 0.624 | 0.048 | 0.048 | 0.040 | 0.064 |

Described from two alates, nine apterous viviparous females, and three apterous oviparous females, all taken by H. V. Scammell at Whitesbog, N. J. The alates and viviparous apterous forms were taken on blueberry on June 28 and July 11, 1915. The oviparous females were taken on December 1, 1914, on "three square" while cranberry bog was being flooded. The specimens marked in the tables of measurements as 10G, 11G, and 12G were collected by Dr. T. L. Guyton at Hartstown, Pa., June 22, 1921, on *Vaccinium corymbosum*. They are designated as paracotypes. Those marked 13G, 14G, and 15G are from Guyton, taken on *Vaccinium stamineum* and appear to be the same, but on a different species of *Vaccinium*. I have also received a single apterous viviparous female taken on *Vaccinium*, species in Massachusetts on July 8, 1921, by Harold Morrison.

*Cotypes.*—Deposited in the U. S. National Museum, No. 26380. Paracotypes in the collection of Dr. T. L. Guyton.

### AMPHOROPHORA VAGANS (Van der Goot)

*Rhopalosiphum vagans* VAN DER GOOT, Records of the Indian Museum, vol. 13, pt. 4, no. 2, 1917, p. 177.

All I know of this species is in Van der Goot's original account.

### AMPHOROPHORA ZHURAVLEVI Mordvilko

*Acyrthosiphon* (*Amphorophora*) *rubi zhuravlevi* MORDVILKO, Fauna de la Russie, vol. 1, liv. 2, 1919, p. 265.

Mordvilko described this form as a subspecies of *rubi* Kaltenbach. I have not seen it, but judging from his description it is a good species. The apterous form can be distinguished from *rubi* Kaltenbach by the differences in proportion of the antennal segments (see page 54). I quote herewith a translation of Mordvilko by A. J. Bruman.

*Apterous viviparous female.*—Depth of frontal furrow represents about three-tenths the distance between the bases of the antennae. Mouth of furrow about two-thirds this distance. The projection of the vertex is distinct. Antennae somewhat longer than the body. The third segment is one and three-sevenths to one and one-half times longer than the fourth and this one is only slightly longer than the fifth. The base of VI equals one-fifth to two-elevenths the length of the third segment, and the unguis of the sixth segment is one and two-ninths times or thereabouts longer than the third. On the third segment near the base there are 3–4 sensoria, its longest hairs reach three-fifths to four-fifths of the diameter of the proximal part of the segment. The cornicles reach one-fifth to two-ninths the length of the body; toward the base they become wider, at one-fourth to one-third from the base they become narrow, from the point to one-third from the end they widen and finally, at the flange they again become narrow. Cornicles without sculpture, except at the very tip one may notice 2–3 transverse, ring-shaped ribs. The cornicles are two and one-half to two and one-third times longer than the cauda. The cauda is long-triangular with uneven lateral edges, with 4–5 bristly hairs on each side. Length of body of two specimens was 3.11–3.21 mm. Color as in *Ac. rubi rubi;* that is, pale yellowish-green.

Measurements of two specimens from Uralsk 3.11–1.47: Frontal furrow, 0.07; between bases of antennae, 0.23; mouth of furrow, 0.14; width of furrow at the middle of its depth, 0.12, at base 0.08; frontal vertex projection, 0.009; hairs on each side, 0.053. Antennae, 3.43, with the following measurements of individual segments: 0.13, 0.10, 0.86, 0.57 (0.59), 0.54, 0.18 (0.17), 1.06. Hairs on the third segment, 0.017–0.035 (0.017–0.031); diameter of proximal part of segment 0.043, near base 3 sensoria. Cornicles 0.66 (0.68), their thickness: 0.10 (base), 0.056 (0.22 from base), 0.070 (0.23 from tip), 0.046 (in front of flange), 0.063 (flange). Cauda, 0.26; its thickness 0.15 (base), 0.12 (0.11 from tip); on each side there are four hairs. The posterior femora, 1.16; tibia, 2.15: tarsi, 0.15 (0.046, 0.13); claws, 0.043; hairs on leg, 0.33, 0.066; the diameter of the proximal part of the leg 0.050, 3.21, 1.54. Frontal projection, 0.009; hairs on the sides, 0.060. Antennae, 3.52, with the following size of separate segments: 0.13, 0.10, 0.86, (0.87), 0.59 (0.61), 0.56 (0.58), 0.18 (0.17), 1.10 (1.06). Hairs on the third segment, 0.014–0.027; diameter of proximal part of segment, 0.047; near the base are 4 sensoria. Cornicles, 0.67; their thickness, 0.10, 0.053 (0.19 from base), 0.070 (0.22 from tip), 0.046 (0.016 from tip). 0.046 (in front of flange), 0.070 (flange). The cauda is 0.29 (length), 0.17 (base), 0.10 (0.14 from end); on each side 4–5 hairs. Posterior femora, 1.16; tibia, 2.32; tarsi, 0.15 (0.046, 0.12); claws, 0.043. Hairs on posterior tibia, 0.026–0.066; diameter of the proximal part of the tibia, 0.053.

*Male.*—The males are winged. Vertex as in *Ac. rubi rubi.* In the antennae the third segment considerably (for instance one and two-fifth times) exceeds the fourth, and this one is one and one-fifth longer than the fifth. The unguis of the sixth segment is one and one-sixth times longer than the third segment, the base of the sixth segment is one-sixth the length of the third. The hairs on the third segment reach almost two-thirds the diameter of the proximal part of the segment. Secondary sensoria are found not only on the third and fifth segments, but also on the fourth. The cornicles reach one-fourth the length of the body, they widen toward the base; from this point to one-fourth from the base they become narrow, then to one-third from the end they widen; from this point to the flange they become narrow again. The head, prothorax, and tubercles of thorax are dark or tawny; the antennae, with the exception of the base of the third segment, and the cornicles are tawny. On the upper part of the abdomen there is on some specimens a median dark stripe (of spots) and on segments 2–5 there are marginal dark disks.

Measurements of one specimen 2.12–0.68: Frontal furrow, 0.07; between the bases of the antennae, 0.20; mouth of furrow, 0.13; width at the middle of its depth 0.11; at base 0.08; frontal vertex projection, 0.007. Antennae, 4.27, with the following measurements of individual segments: 0.12, 0.08, 1.14 (1.13), 0.83 (0.82), 0.69, 0.18+1.23. Hairs on the third segment, 0.017–0.029; diameter of proximal part of segment, 0.047. Sensoria on the third segment placed thickly over its entire length; on the fourth segment there are 3 (8) sensoria; on the fifth 15 (14) in addition to the permanent one. The cornicles are 0.55; their thickness, 0.066 (base), 0.042 (0.12 from base), 0.066 (0.17 from end), 0.042 (0.013 from end), 0.040 (in front of flange), 0.062 (flange). Cauda, 0.16 (length), 0.12 (base), 0.08 (0.09 from tip); on each side are five hairs. The posterior femur, 1.14; tibia, 2.28; tarsi, 0.14 (0.04, 0.11); claws, 0.043.

*Distribution.*—These aphids are so far known from the environs of the city of Uralsk. Apparently it is distributed over Siberia, at least Western Siberia. Unfortunately there is no material at present from various parts of Siberia. On the lower part of the river Amur occurs *Ac. rubi amurense.*

*Life habits.*—During the first part of September in the vicinity of Uralsk there were collected wingless females, a young oviparous female (in the fourth stage of development), a winged male and a nymph of a male. In general the life history must be identical with that of *Ac. rubi rubi.*

## SPECIES NOT PLACED

Following are descriptions of two alate males, which I have not placed specifically.

### Pergande No. 5591

Antennae about twice as long as body, dark colored, very tuberculate; hairs small, much shorter than width of segment. Antennal tubercles very small. Small prothoracic tubercles showing. Abdomen with lateral dark patches. Cornicles of uniform color, long, plainly swollen, faintly imbricated at tip. Cauda constricted, one dorsal and three lateral hairs present.

| III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|
| 0. 768<br>0. 752 | 56<br>60 | 0. 512<br>0. 512 | 25<br>22 | 0. 448<br>0. 432 | 8<br>9 | 0. 128+0. 784<br>0. 152+0. 928 |

| Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|
| | | Length | Wide X | Small X | Flange |
| 0. 480 | 0. 16 | 0. 352<br>0. 400 | 0. 072<br>0. 072 | 0. 04<br>0. 04 | 0. 048<br>0. 048 |

Pergande left the following note:

"5591? *Rhop. lactucae?* December 4.94. Found one winged male on under side of leaf of turnip, which may belong to this species. Dark parts black; light parts yellow. Prothorax in front and behind orange; base and end of abdomen orange, rest yellow, six dusky transv. medio-dorsal spots; lateral spots black. Mounted in balsam."

**Quaintance No. 22023, Bragg No. 117**

Taken on grass at Marblehead, Mass., October 11, 1920, by L. C. Bragg.

*Alate Male.*—Antennae dark colored, very tuberculate. Hairs long, heavy, conspicuous. Antennal tubercles very short. Beak reaching second coxae. No prothoracic or abdominal tubercles showing. Cornicles long, moderately swollen, dark colored, lighter at base, inconspicuously reticulate at tip. Cauda long, slender, constricted. Measurements as follows:

*Antennal measurements*

| No. | III | Sensoria on III | IV | Sensoria on IV | V | Sensoria on V | VI |
|---|---|---|---|---|---|---|---|
| 1 | 0.864 | 90 | 0.480 | 25 | 0.448 | 14 | 0.112+? |
| | 0.832 | 81 | 0.448 | 24 | 0.492 | 16 | 0.112+? |
| 2 | 0.816 | 69 | ? | ? | ? | ? | ? |
| | 0.816 | 66 | ? | ? | ? | ? | ? |

*Other measurements*

| No. | Head | Cauda | Cornicle | | | |
|---|---|---|---|---|---|---|
| | | | Length | Wide X | Small X | Flange |
| 1 | 0.520 | 0.184 | 0.488 | 0.080 | 0.04 | 0.048 |
| 2 | 0.516 | 0.160 | 0.448 | 0.072 | 0.04 | 0.048 |
| | | | 0.432 | 0.072 | 0.04 | 0.048 |

*Last instar nymph*

| III | IV | V | VI | Head | Cornicle length | Cornicle width |
|---|---|---|---|---|---|---|
| 0.480 | 0.304 | 0.304 | 0.08+0.784 | 0.608 | 0.416 | 0.096 |
| 0.480 | 0.272 | 0.288 | 0.08+ ? | | 0.416 | 0.112 |

## EXPLANATION OF PLATES

### PLATE 1

1–3. *Amphorophora alni*, new species.

(Drawings by the author.)

1. Cornicle and cauda of apterous form. 2. Head of apterous form. 3. Antennae of apterous form.

4–6. *Amphorophora braggi*, new species.

(Drawings by Mrs. Awl.)

4. Antennae of alate form. 5. Head of alate form. 6. Cornicle and cauda of alate form.

7–9. *Amphorophora brittenii* (Theobald).

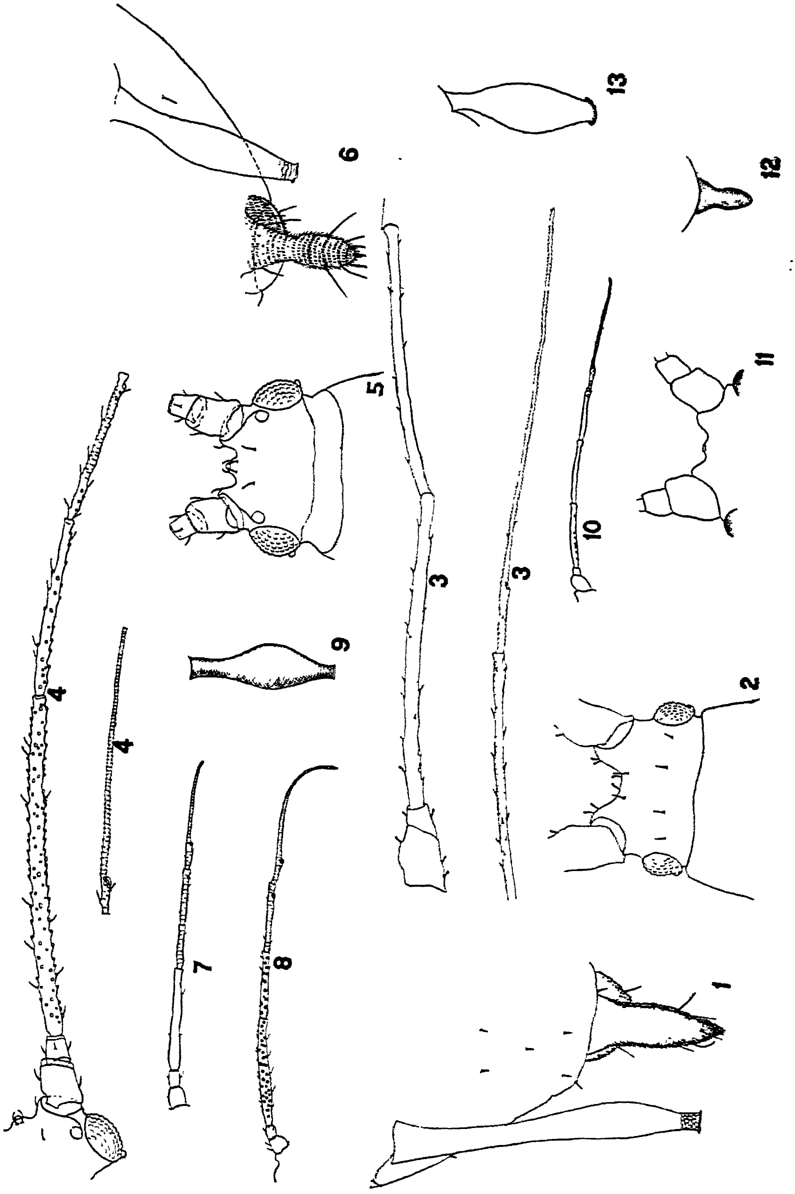
(Redrawn by Mrs. Awl from Theobald.)

7. Antenna of apterous form. 8. Antenna of alate form. 9. Cornicles of alate form.

10–13. *Amphorophora solani* (Thomas).

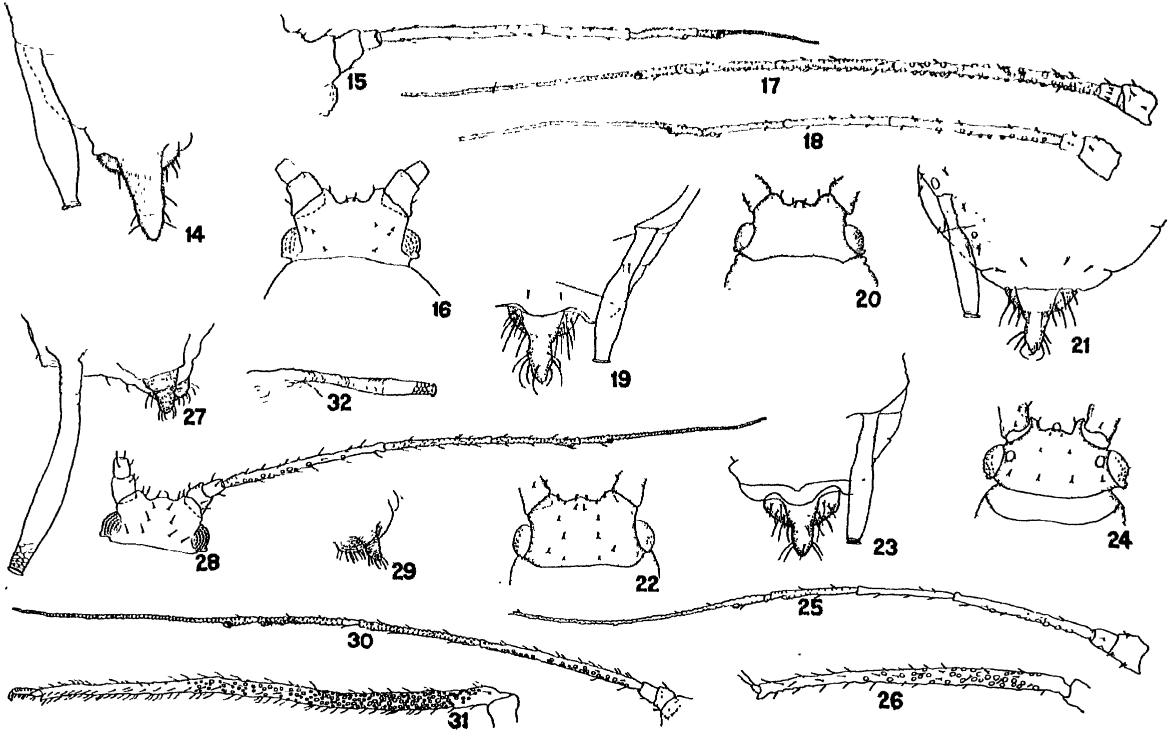
(Redrawn by Mrs. Awl from Davis.)

10. Antenna of alate form. 11. Head of alate form. 12. Cauda of alate form. 13. Cornicle of alate form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 74



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 75

## PLATE 2.

14–26. *Amphorophora cosmopolitana*, new name.
(Drawings by the author.)
14. Cornicle and cauda of apterous spring form (drawing by Mrs. Awl). 15. Antenna of apterous, spring form (by Mrs. Awl). 16. Head of apterous spring form (by Mrs. Awl). 17. Antenna of alate summer form. 18. Antenna of apterous summer form. 19. Cornicle and cauda of apterous summer form. 20. Head of oviparous female. 21. Cornicle and cauda of alate summer form. 22. Head of apterous summer form. 23. Cornicle and cauda of oviparous female. 24. Head of summer alate form. 25. Antenna of oviparous female. 26. Posterior tibia of oviparous female.

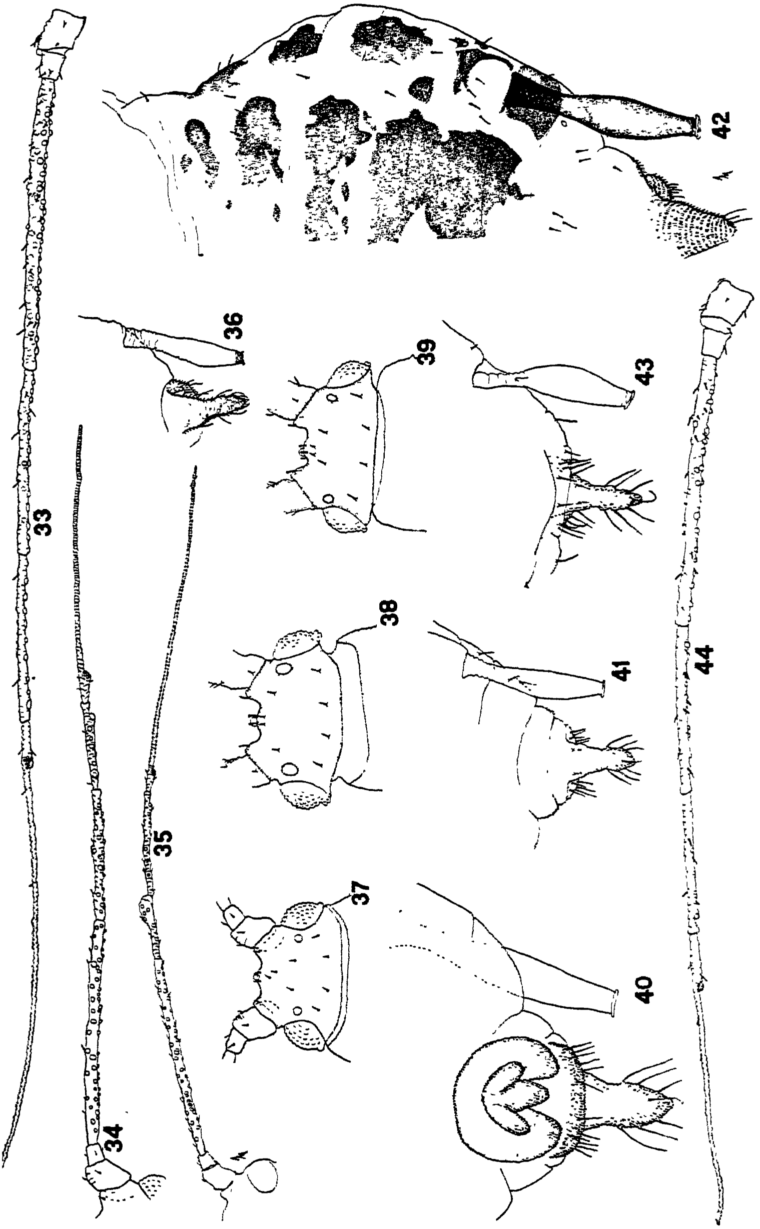
27–32. *Amphorophora davidsoni*, new species.
(Drawings by Mrs. Awl.)
27. Cornicle and cauda of oviparous female. 28. Head and antenna of oviparous female. 29. Cauda of male. 30. Antenna of male. 31. Posterior tibia of oviparous female. 32. Cornicle of male.

## PLATE 3.

33–44. *Amphorophora cosmopolitana*, new name.

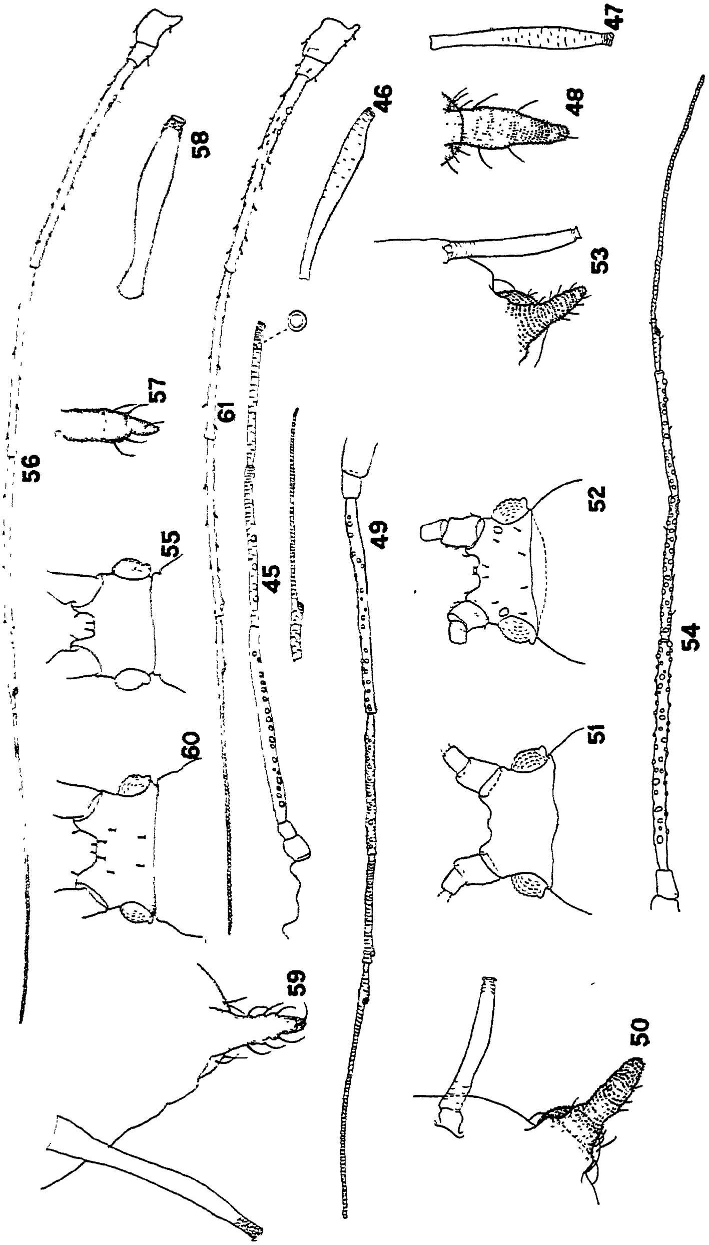
(Drawings by the author.)

33. Antenna of male. 34. Antenna of alate spring form (drawing by Mrs. Awl). 35. Deformed antenna of male (drawing by Mrs. Awl). 36. Cornicle and cauda of alate spring form (drawing by Mrs. Awl). 37. Head of alate spring form (drawing by Mrs. Awl). 38. Head of male. 39. Head of fall migrant. 40. Male. 41. Cornicle and cauda of male. 42. Abdomen of male (drawing by Mrs. Awl). 43. Cornicle and cauda of fall migrant. 44 Antenna of fall migrant.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 76



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 77

## PLATE 4

45–48. *Amphorophora carduellina* (Theobald).
(Redrawn by Mrs. Awl from Theobald.)
45. Antenna of apterous form. 46–47. Cornicle of apterous form. 48. Cauda of apterous form.

49–54. *Amphorophora oleraceae* (v. d. Goot).
(Drawings by Mrs. Awl.)
49. Antenna of apterous form. 50. Cornicle and cauda of apterous form. 51. Head of apterous form. 52. Head of alate form. 53. Cornicle and cauda of alate form. 54. Antenna of alate form.

55–58. *Amphorophora pallida*, new species.
(Drawings by author.)
55. Head of apterous form. 56. Antenna of apterous form. 57 Cauda of apterous form. 58. Cornicle of apterous form.

59–61. *Amphorophora rhododendronia*, new species.
(Drawings by author.)
59. Cornicle and cauda of apterous form. 60. Head of apterous form. 61. Antenna of apterous form.

## PLATE 5

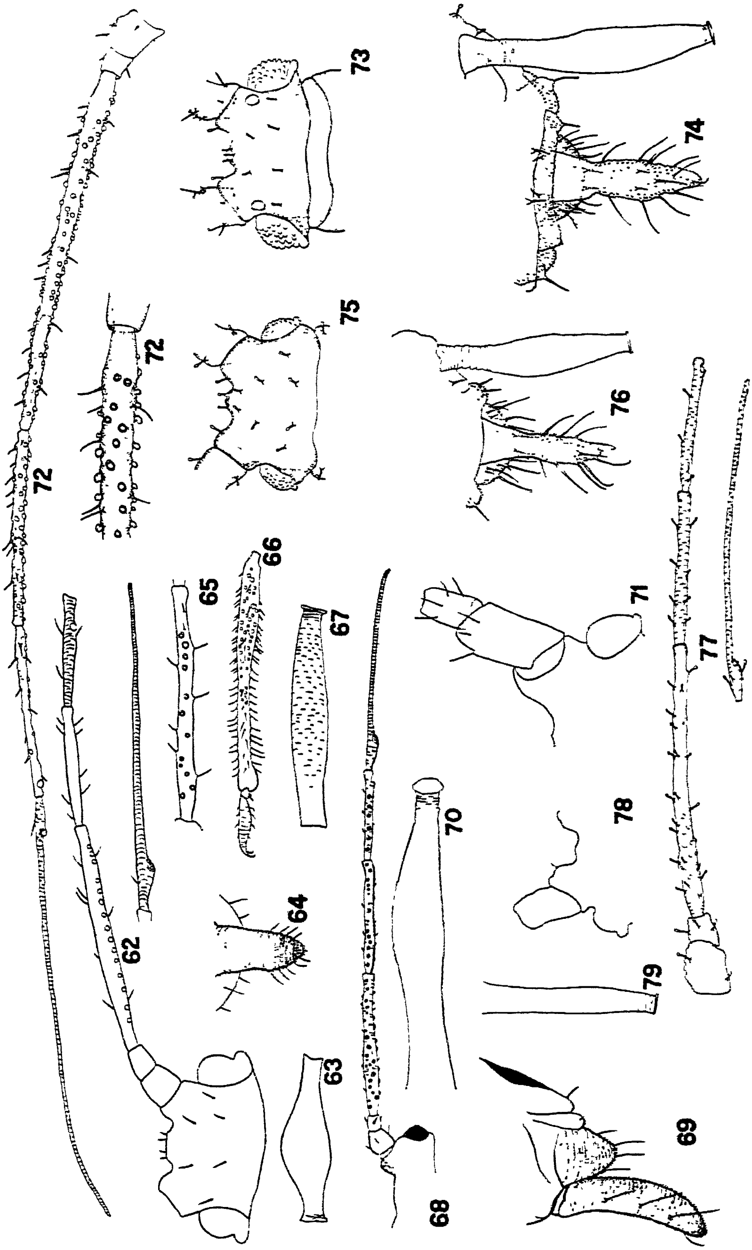
62–66. *Amphorophora brittenii* (Theobald).
(Redrawn by Mrs. Awl from Jackson.)
62. Head and antenna of oviparous female. 63. Cornicle of oviparous female. 64. Cauda of oviparous female. 65. Segment III of antenna, oviparous female. 66. Posterior tibia and tarsi of oviparous female.

67–69. *Amphorophora carduellina* (Theobald).
(Redrawn by Mrs. Awl from Theobald.)
67. Cornicle of alate form. 68. Head and antenna of alate form. 69. Alate form.

70–71. *Amphorophora formosana* Takahashi.
(Redrawn by Mrs. Awl from Takahashi.)
70. Cornicle of apterous form. 71. Head of apterous form.

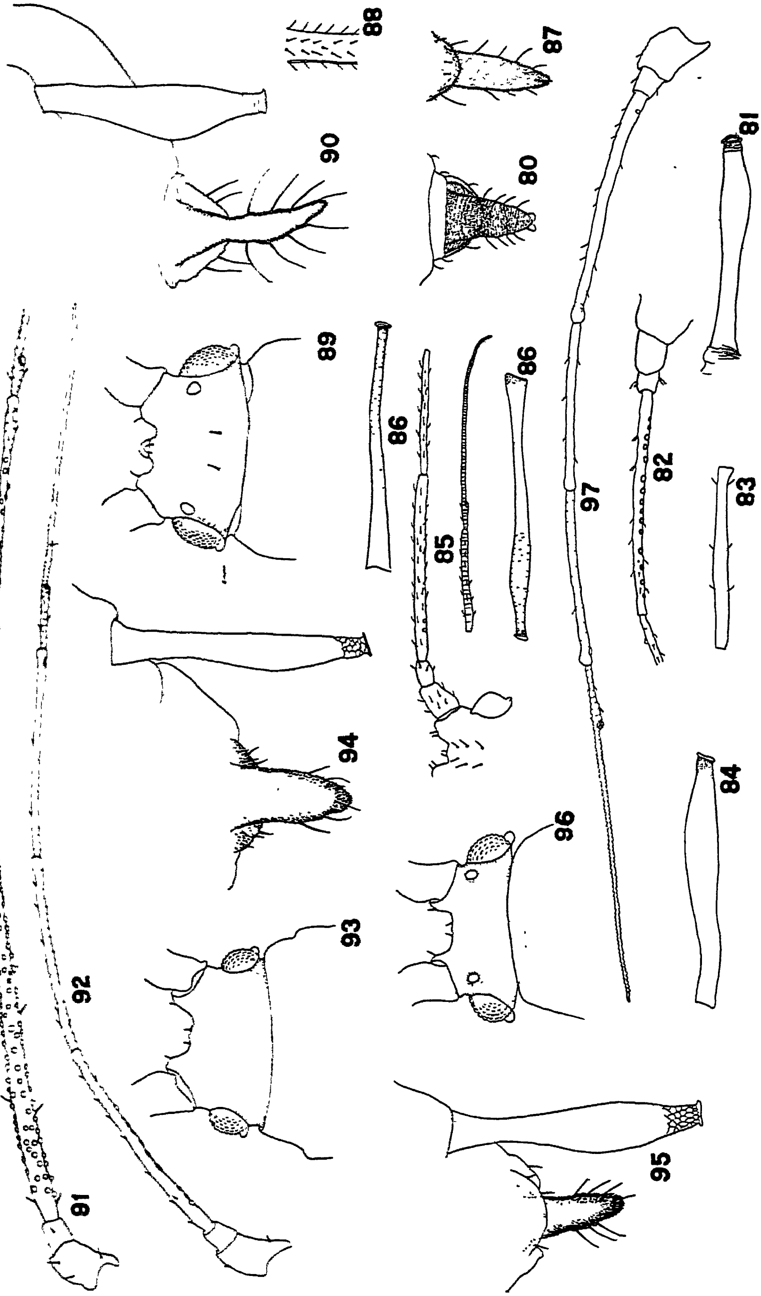
72–77. *Amphorophora pergandei*, new species.
(Drawings by the author.)
72. Antenna of alate form. 73. Head of alate form. 74. Cornicle and cauda of alate form. 75. Head of apterous form. 76. Cornicle and cauda of apterous form. 77. Antenna of apterous form.

78–79. *Amphorophora takahashii*, new species.
(Redrawn by Mrs. Awl from Takahashi.)
78. Head of apterous form. 79. Cornicle of apterous form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 78



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 79

## PLATE 6

80–84. *Amphorophora cicutae* Shinji.

(Drawings by Mrs. Awl from photomicrograph of type.)

80. Cauda of alate form. 81. Cornicle of alate form. 82. Antenna of alate form. 83. Antennal segment III of apterous form (from Shinji). 84. Cornicle of apterous form (from Shinji).

85–88. *Amphorophora evansi* Theobald.

(Redrawn by Mrs. Awl from Theobald.)

85. Head and antenna of apterous form. 86. Cornicles of apterous form. 87. Cauda of apterous form. 88. Tibia of apterous form.

89–91. *Amphorophora hayhursti*, new species.

(Drawings by author.)

89. Head of alate form. 90. Cornicle and cauda of alate form. 91. Antenna of alate form.

92–97. *Amphorophora morrisoni* (Swain).

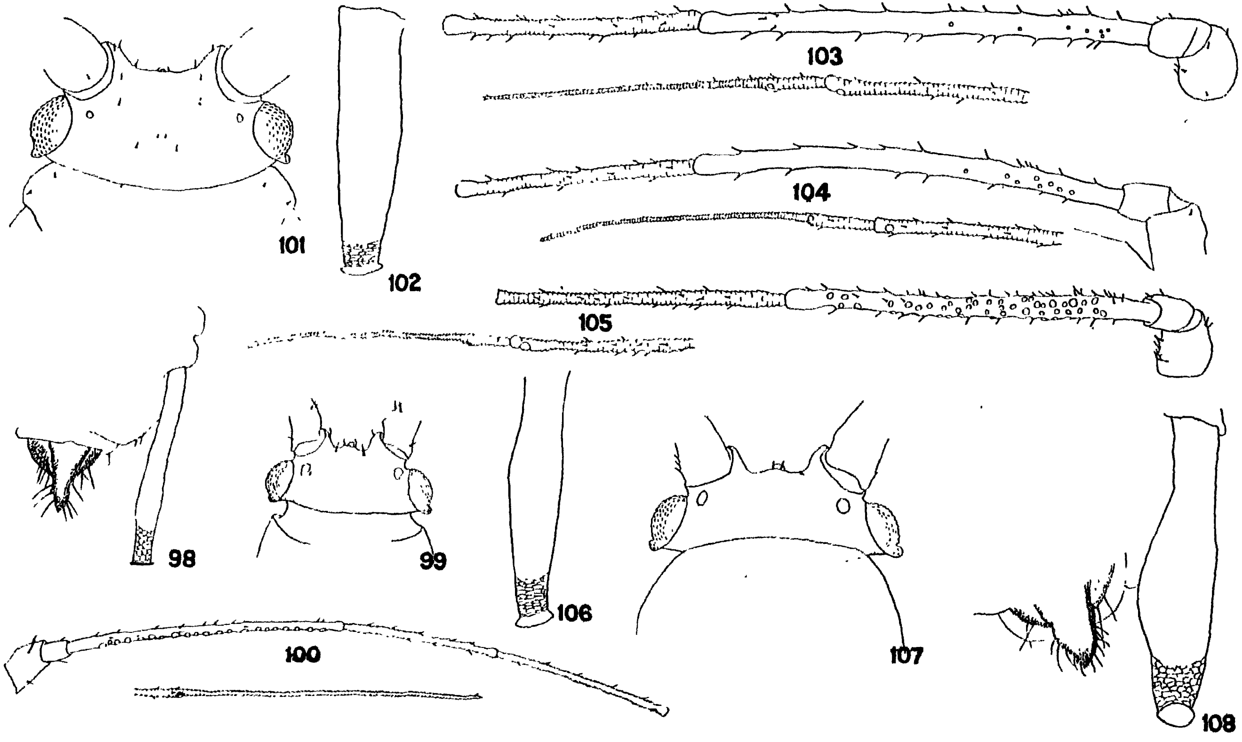
(Drawings by author.)

92. Antenna of alate form. 93. Head of apterous form. 94. Cornicle and cauda of apterous form. 95. Cornicle and cauda of alate form. 96. Head of alate form. 97. Antenna of apterous form.

## PLATE 7

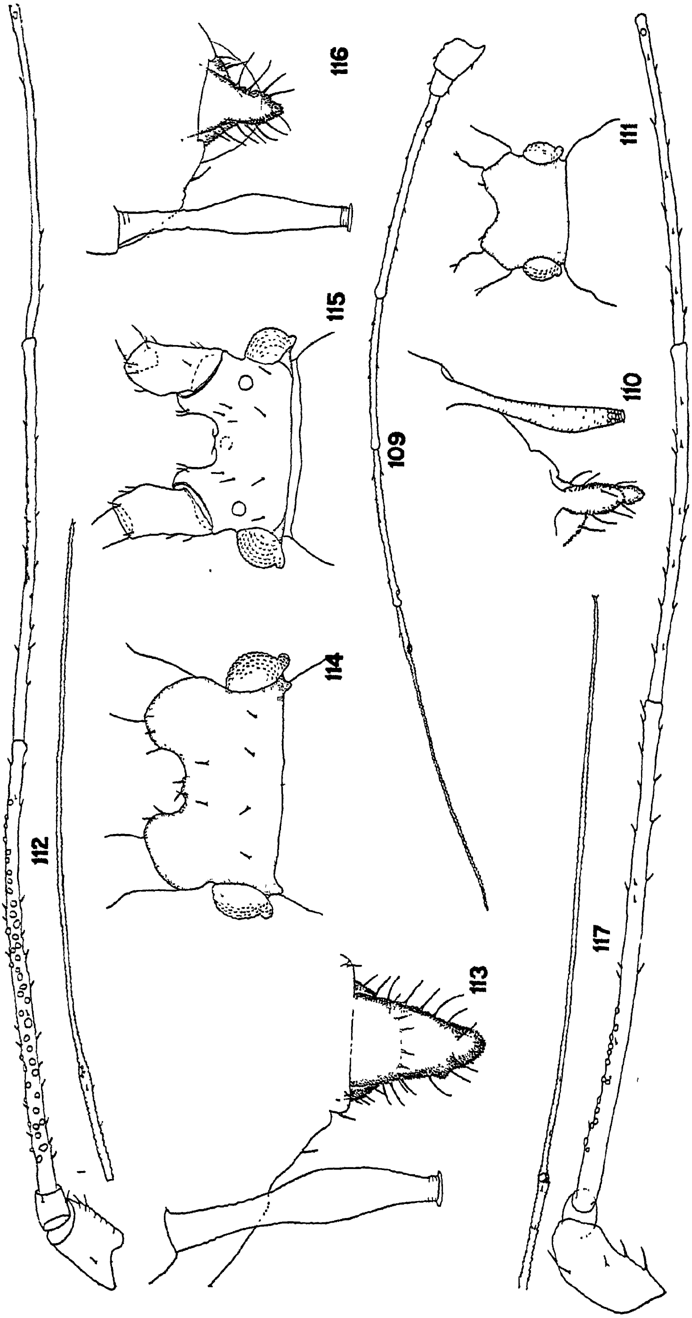
98–100. *Amphorophora corylina* (Davidson).
(Drawings by the author.)
98. Cornicle and cauda of alate form. 99. Head of alate form. 100. Antenna of alate form.

101–108. *Amphorophora essigwanai*, new name.
(Drawings by the author.)
101. Head of intermediate form. 102. Cornicle of intermediate form. 103. Antenna of intermediate form. 104. Antenna of apterous form. 105. Antenna of alate form. 106. Cornicle of apterous form. 107. Head of alate form. 108. Cornicle and cauda of alate form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 180



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 81

## PLATE 8

109–111. *Amphorophora borealis*, new species.
(Drawings by the author.)
109. Antenna of apterous form. 110. Cornicle and cauda of apterous form. 111. Head of apterous form.

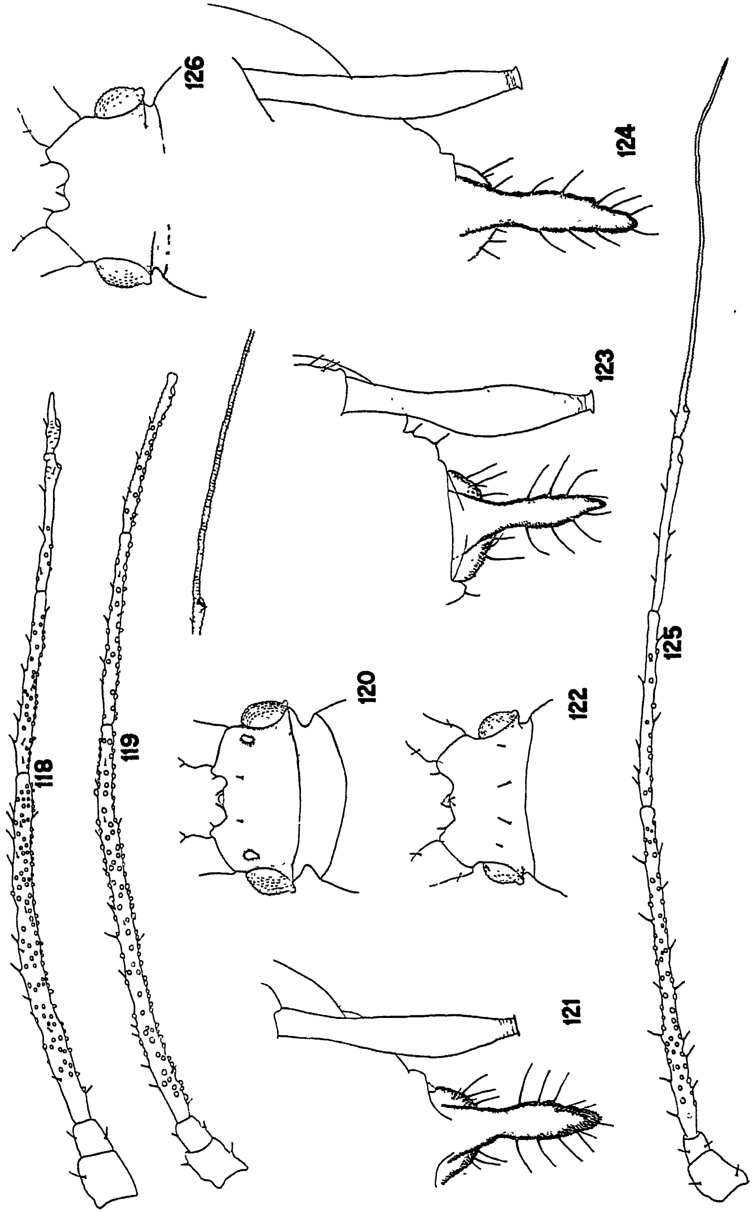
112–117. *Amphorophora laingi*, new species.
(Drawings by the author.)
112. Antenna of alate form. 113. Cornicle and cauda of apterous form. 114. Head of apterous form. 115. Head of alate form (drawing by Mr. Awl). 116. Cornicle and cauda of alate form. 117. Antenna of apterous form.

## PLATE 9

118–126. *Amphorophora nabali* (Oestlund).

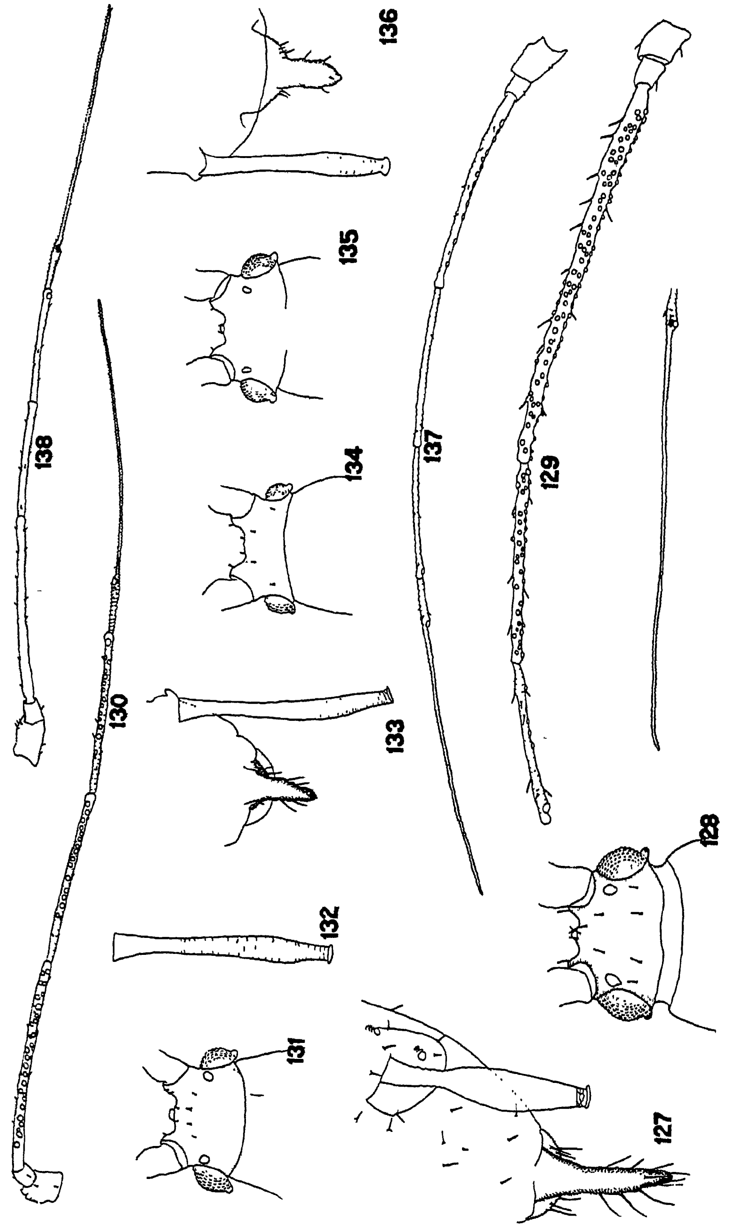
(Drawings by the author.)

118. Antenna of intermediate form. 119. Antenna of alate form. 120. Head of alate form. 121. Cornicle and cauda of apterous form. 122. Head of apterous form. 123. Cornicle and cauda of alate form. 124. Cornicle and cauda of intermediate form. 125. Antenna of apterous form. 126. Head of intermediate form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 82



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 83

## PLATE 10

127–129. *Amphorophora mitchelli*, new species.
(Drawings by the author.)
127. Cornicle and cauda of alate form. 128. Head of alate form 129. Antenna of alate form.

130–138. *Amphorophora nervata* (Gillette).
(Drawings by the author.)
130. Antenna of male. 131. Head of male. 132. Cornicle of male. 133. Cornicle and cauda of alate form. 134. Head of apterous form. 135. Head of alate form. 136. Cornicle and cauda of apterous form. 137. Antenna of alate form. 136. Antenna of apterous form.

## PLATE 11

139–141. *Amphorophora davidsoni*, new species.

(Drawings by the author.)

139. Antenna of alate form. 140. Head of alate form. 141. Cornicle and cauda of alate form.

142–143. *Amphorophora reticulata*, new species.

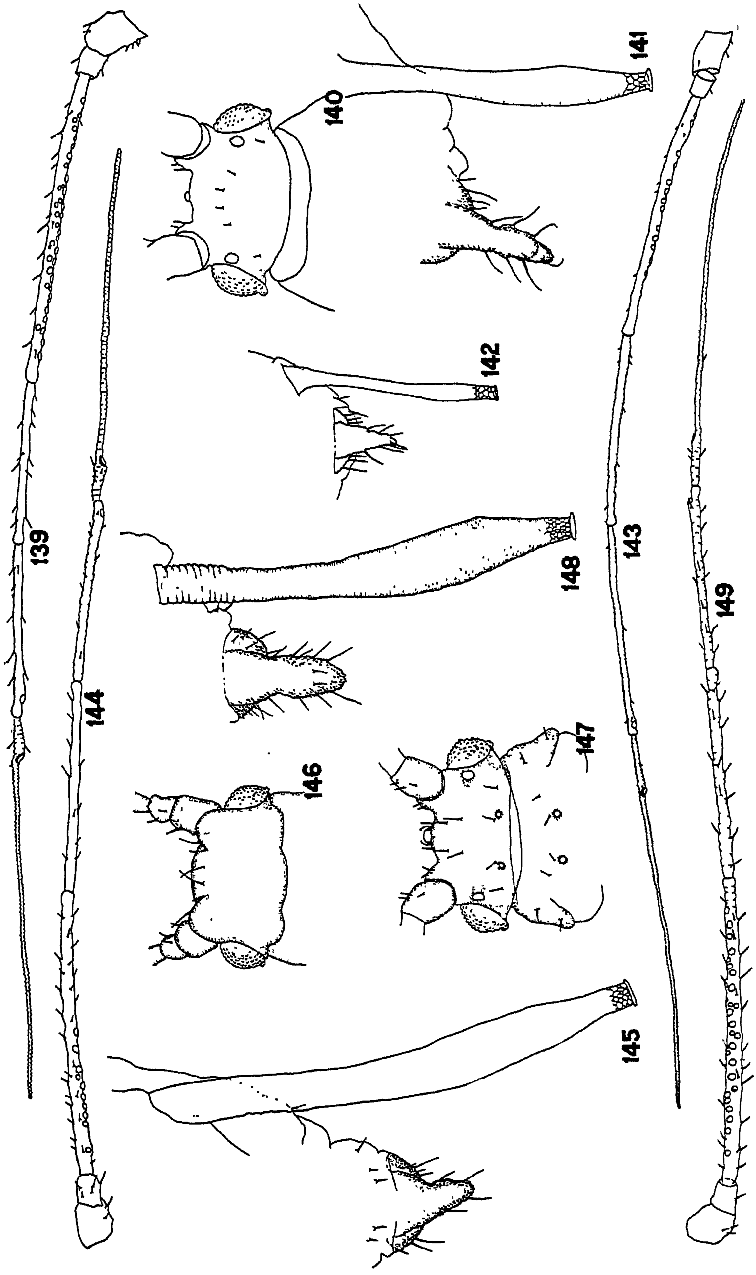
(Drawings by the author.)

142. Cornicle and cauda of alate form. 143. Antenna of alate form.

144–149. *Amphorophora rubicola* (Oestlund).

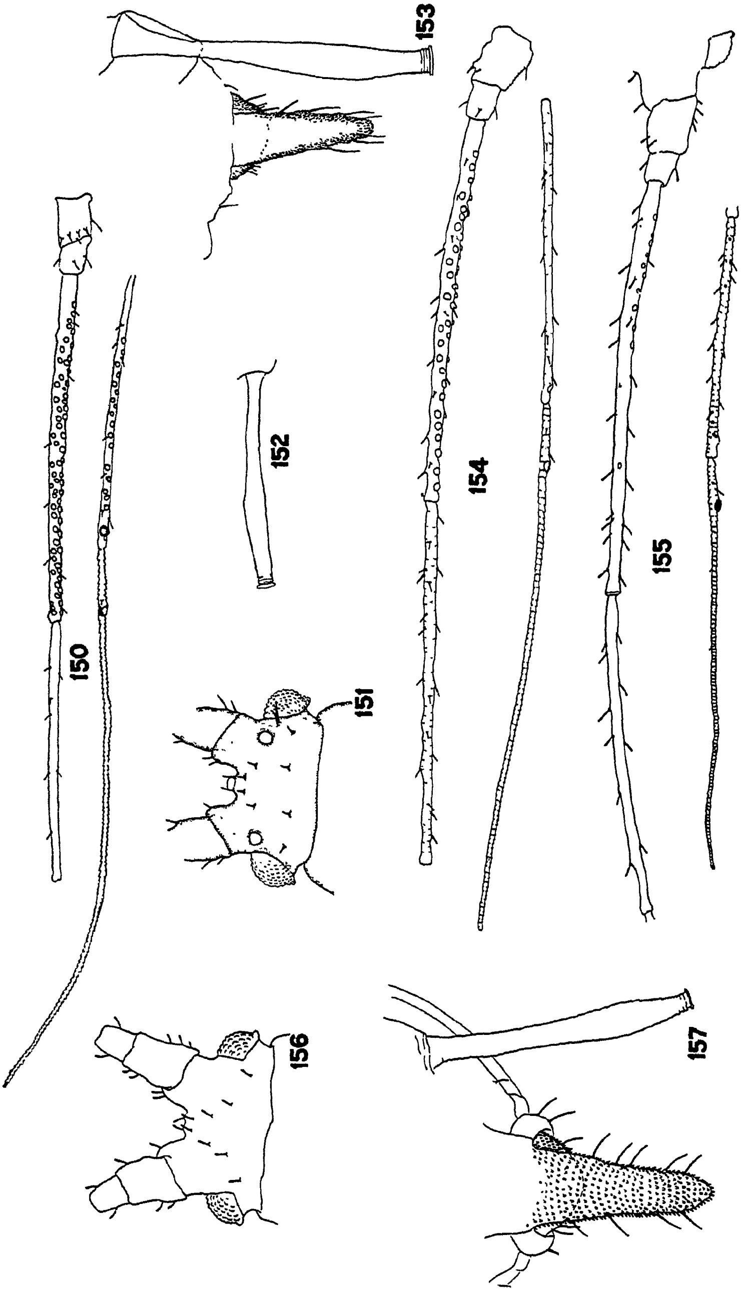
(Drawings by the author.)

144. Antenna of apterous form. 145. Cornicle and cauda of apterous form. 146. Head of apterous form. 147. Head of alate form. 148. Cornicle and cauda of alate form. 149. Antenna of alate form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 84



Aphids of the Genus Amphorophora

For explanation of plate see page 85

## PLATE 12

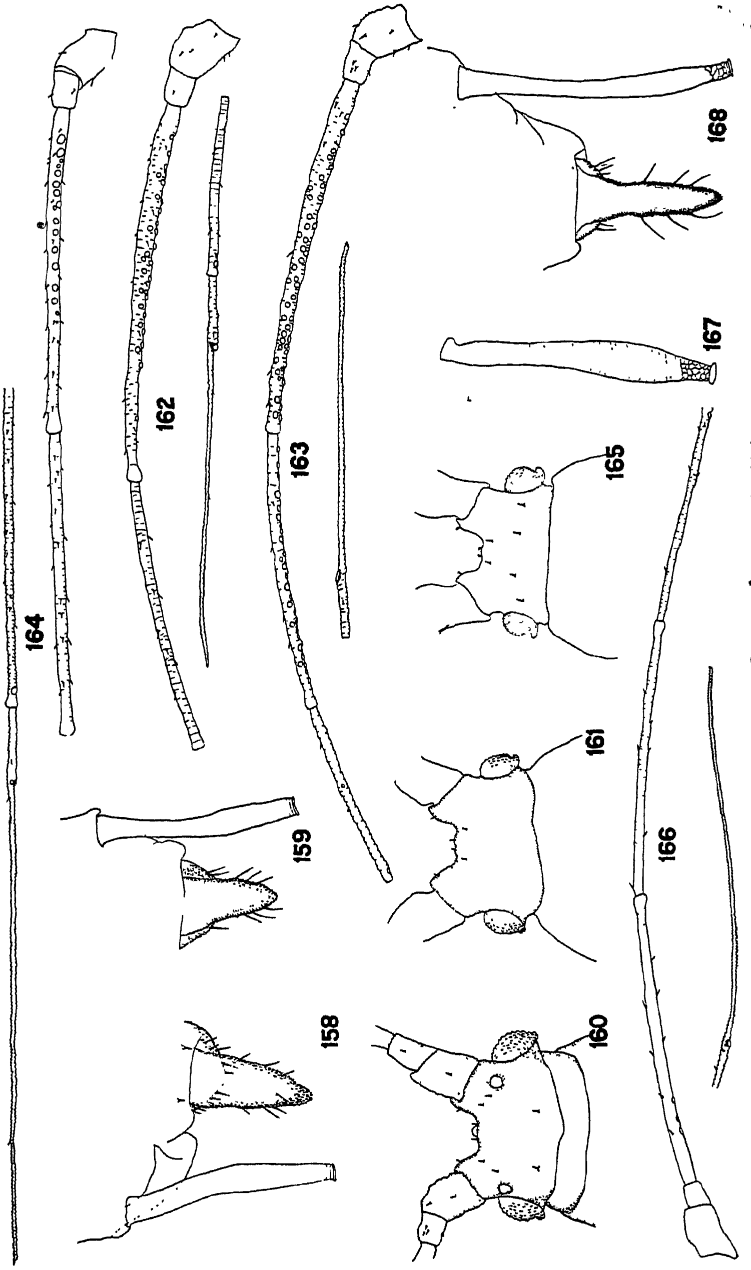
150–157. *Amphorophora rubi* (Kaltenbach).
(Drawings by the author.)

150. Antenna of male. 151. Head of alate form. 152. Cornicle of male. 153. Cornicle and cauda of alate form. 154. Antenna of alate form. 155. Antenna of apterous form. (Drawing by Mrs. Awl.) 156. Head of apterous form. (Drawings by Mrs. Awl.) 157. Cornicle and cauda of apterous form. (Drawing by Mrs. Awl.)

## PLATE 13

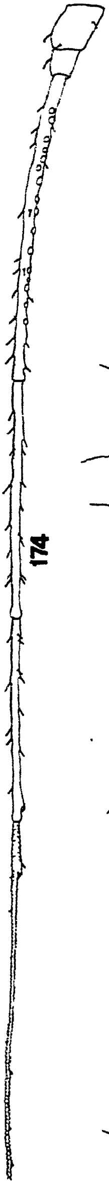
158–163. *Amphorophora sensoriata* Mason.
(Drawings by the author.)
158. Cornicle and cauda of apterous form. 159. Cornicle and cauda of alate. 160. Head of alate form. 161. Head of apterous form. 162. Antenna of apterous form. 163. Antenna of alate form.

164–168. *Amphorophora spiraecola* (Patch).
(Drawings by the author.)
164. Antenna of alate form. 165. Head of apterous form. 166. Antenna of apterous form. 167. Cornicle of alate form. 168. Cornicle and cauda of apterous form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 86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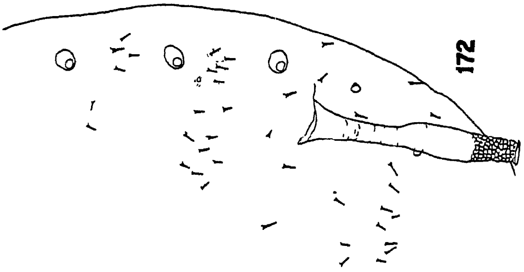
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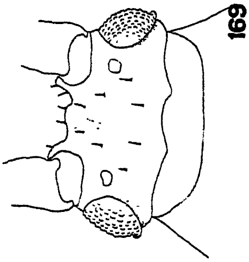
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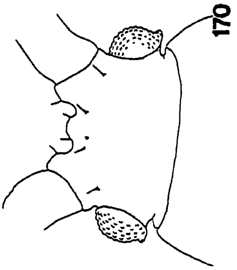
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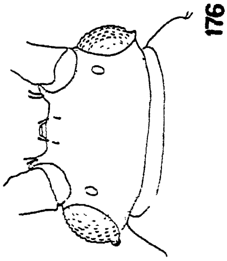
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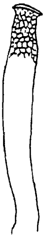
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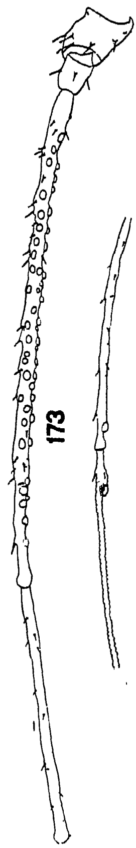
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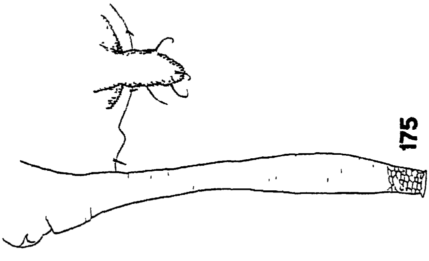
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APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 87

## PLATE 14

169–173. *Amphorophora aconiti* (van der Goot).
(Drawings by the author.)
169. Head of alate form. 170. Head of apterous form. 171. Cornicle of apterous form. 172. Abdomen and cornicle of alate form. 173. Antenna of alate form.

174–176. *Amphorophora maxima*, new species.
(Drawings by the author.)
174. Antenna of alate form. 175. Cornicle and cauda of alate form. 176. Head of alate form.

## PLATE 15

177–178. *Amphorophora minima*, new species.
(Drawings by the author.)
177. Antenna of alate form. 178. Cornicle of alate form.

179–188. *Amphorophora vaccinii*, new species.
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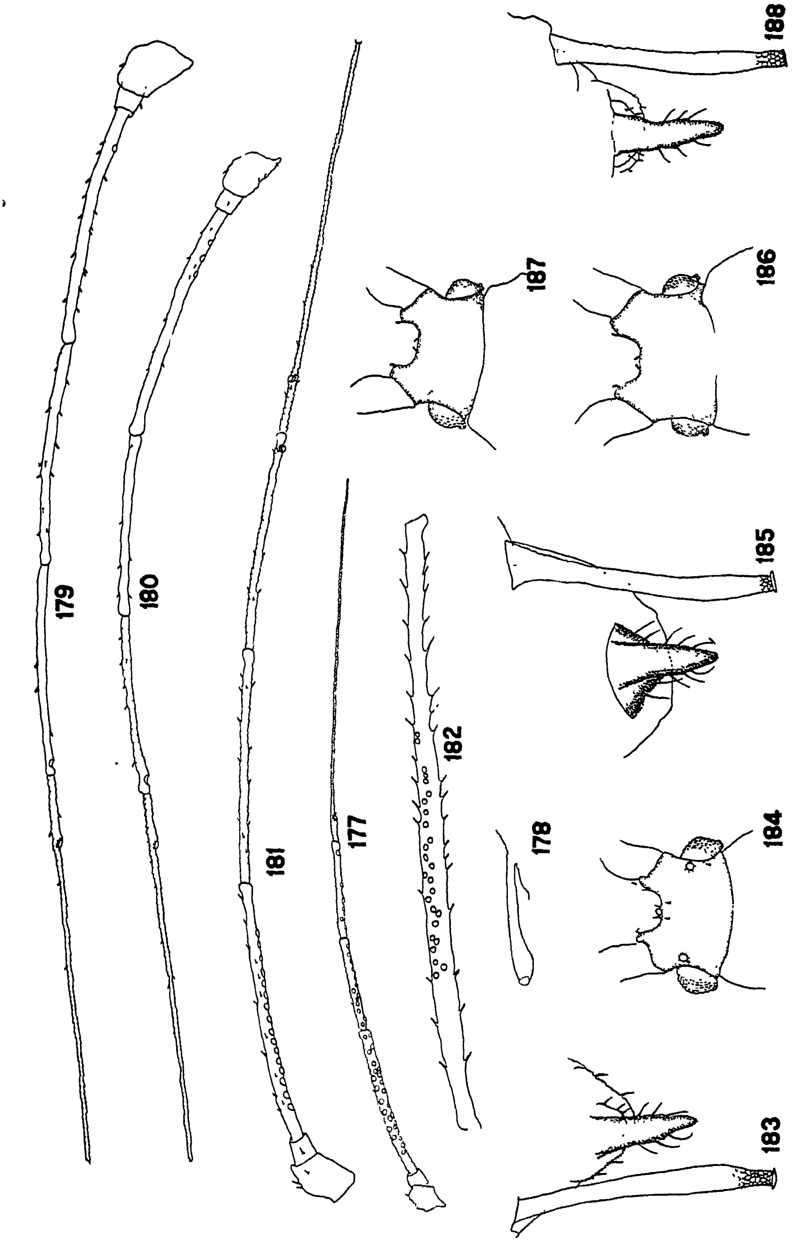
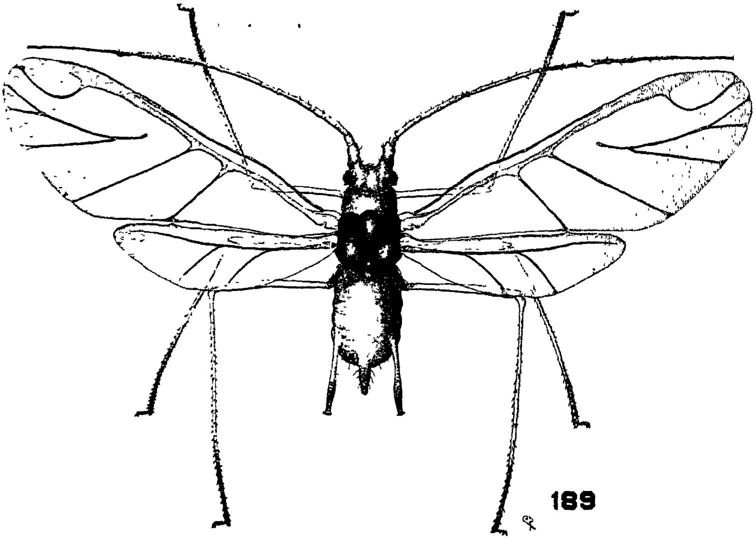
179. Antenna of oviparous female. 180. Antenna of apterous form. 181. Antenna of alate form. 182. Posterior tibia of oviparous female. 183. Cornicle and cauda of alate form. 184. Head of alate form. 185. Cornicle and cauda of oviparous female. 186. Head of oviparous female. 187. Head of apterous form. 188. Cornicle and cauda of apterous form.



APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 88



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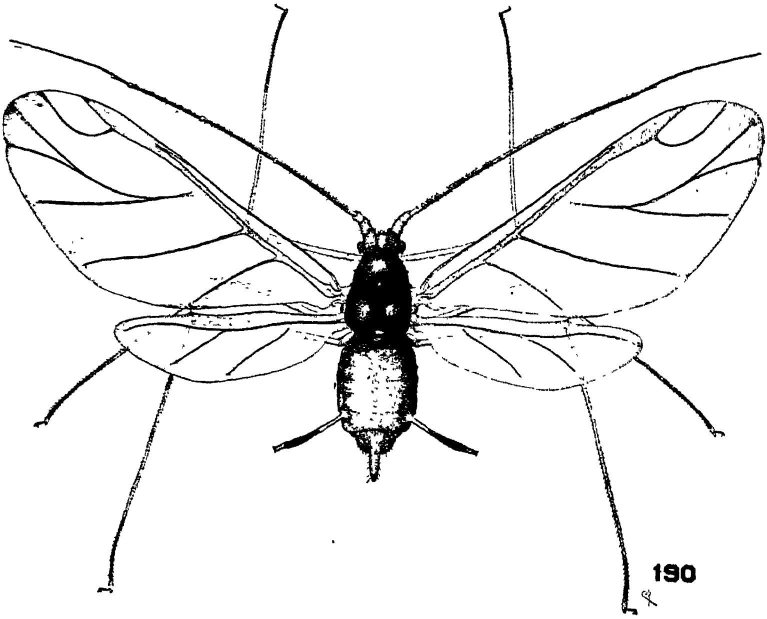

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APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 89

## PLATE 16

(Drawings by Carlo Zeimet.)

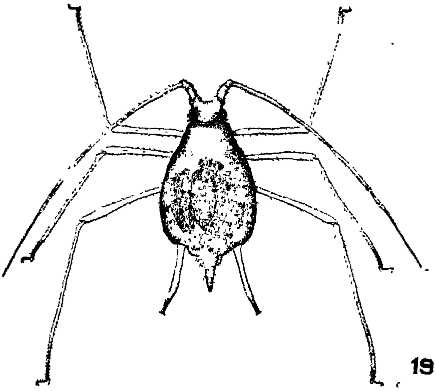
189. *Amphorophora laingi,* new species.
190. *Amphorophora rubi* (Kaltenbach).

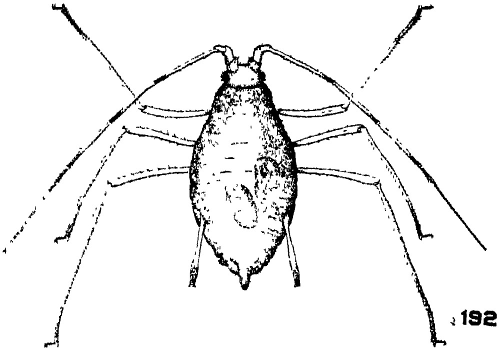
PLATE 17

(Drawings by Carlo Zeimet.)

191. *Amphorophora vaccinii*, new species.
Apterous form.

192. *Amphorophora vaccinii*, new species.
Oviparous female.





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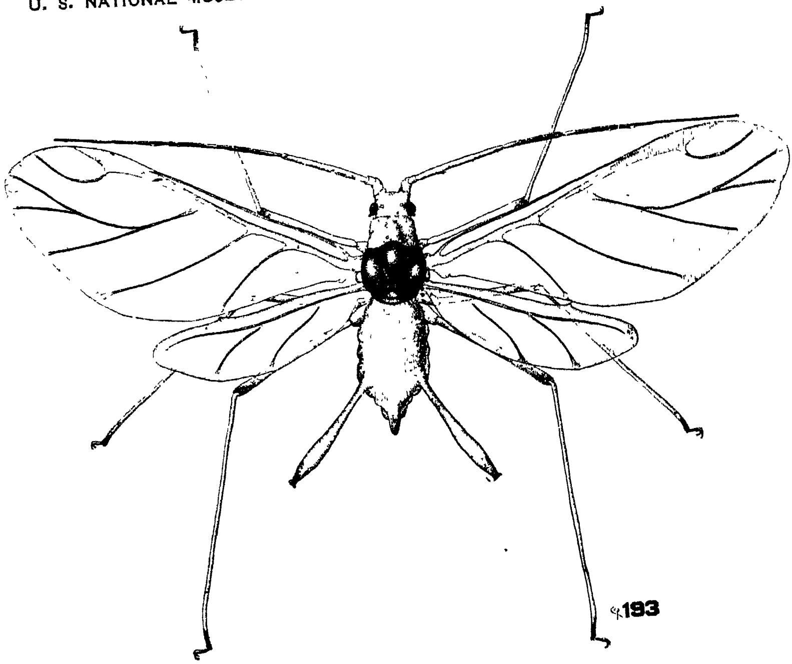
FOR EXPLANATION OF PLATE SEE PAGE 90



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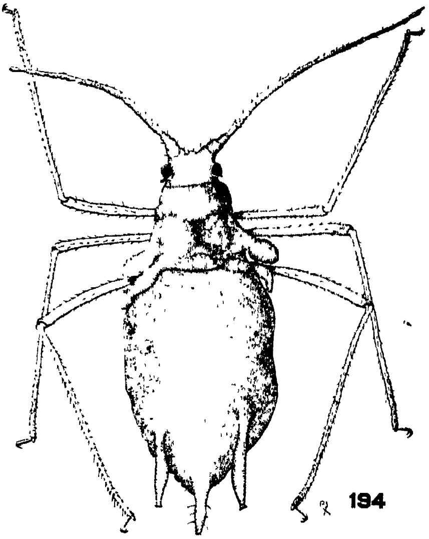

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APHIDS OF THE GENUS AMPHOROPHORA

FOR EXPLANATION OF PLATE SEE PAGE 91

PLATE 18

(Drawings by Carlo Zeimet.)

**193.** *Amphorophora rubicola* (Oestlund).
**194.** *Amphorophora nabali* (Oestlund).
Intermediate form.

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# STUDIES ON THE CYCLOSTOMATOUS BRYOZOA

By Ferdinand Canu
*Of Versailles, France*
AND
Ray S. Bassler
*Of Washington, District of Columbia*

The present paper is our second contribution to the above subject, the first having been published in 1922[1] under the subtitle of "Fossil and Recent Parallelata and Rectangulata." As explained in this first paper, our efforts are especially directed, first, to the study of the internal structure of these organisms by means of thin sections in order to determine the method of gemmation and the occurrence and structure of the various kinds of tubes, and, second, to the function of reproduction as brought out by the ovicells. Cyclostomatous bryozoa are extremely abundant in certain Mesozoic rocks; indeed, they form almost the entire bryozoan fauna of most formations before the Upper Cretaceous.

## 2. LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

The Cretaceous Cyclostomata have received attention from many authors, but particularly through the work of D'Orbigny in volume 5 of the Paléontologie française and Gregory in his two volumes of the Catalogue of the Cretaceous Bryozoa in the British Museum. Both of these authors, in fact most previous students, have adoped an artificial classification which in the number of genera proposed and the slight reasons for their existence is amazing. Gregory's two volumes are valuable contributions to the bibliographic and historical sides of the subject and his studies of the internal structure mark a great advance in the science. Our studies carry Gregory's efforts still further; in fact, our main object has been an effort to determine the natural generic characters in this group.

We have undertaken the study of the Lower Cretaceous Cyclostomata at this time due to our possession of ample, well-preserved

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[1] Proc. U. S. Nat. Mus., vol. 61, pp. 1-160, 28 pls., 40 text figs.

No. 2593.—Proceedings U. S. National Museum, Vol. 67, Art. 21.

collections from the two classic localities, Faringdon[2], England, and Sainte-Croix, Switzerland. The Faringdon specimens coming from the Aptian division of the Lower Cretaceous were secured for us personally by W. E. Crane, of Washington, D. C., who with his usual generosity presented all of the material to the United States National Museum for study. Mr. Crane not only obtained an excellent representation of the large forms but also made extensive siftings of the Faringdon sands, thus securing many small ramose examples which are usually overlooked by collectors.

The Swiss Lower Cretaceous material from the locality in the Valangian division at Sainte-Croix was loaned us for study through the courtesy of Dr. Samuel Henshaw, director of the Museum of Comparative Zoology at Cambridge, Mass. All of the type specimens from Faringdon are the property of the United States National Museum while those from Sainte-Croix are shared with the Museum of Comparative Zoology.

Gregory's excellent bibliography of papers dealing with Cretaceous bryozoa published in volume 2 of his Catalogue of Fossil Bryozoa in the British Museum makes it unnecessary for us to quote the literature upon this subject. We have not been able to rediscover all the species described from the two localities studied, but we give in the following two lists all of the species considered in the present paper.

## ALPHABETIC LIST OF BRYOZOA

### LOWER CRETACEOUS (APTIAN) FARINGDON, ENGLAND

*Berenicea faringdonensis*, new species.
*Berenicea filifera*, new species.
*Berenicea grandipora*, new species.
*Berenicea pulchella* De Loriol, 1863.
*Berenicea* (*Reptomultisparsa*) *tenella* De Loriol, 1868.
*Berenicea parvula*, new species.
*Cardioecia faringdonensis*, new species.
*Cardioecia pauper*, new species.
*Cea granulata*, new species.
*Cellulipora spissa* Gregory, 1899.
*Ceriopora dimorphocella*, new species.
*Clausa cranei*, new species.
*Clausa zonifera*, new species.
*Clinopora quadripartita*, new species.
*Diaperoecia orbifera*, new species.
*Diaperoecia simplex*, new species.
*Heteropora nummularia*, new species.
*Laterocavea dutempleana* D'Orbigny, 1853.
*Laterocavea intermedia*, new species.
*Lobosoecia semiclausa* Michelin, 1845.
*Meliceritites cunningtoni* Gregory, 1899.

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[2] The several spellings of this name are known to us but we understand that the present form of the word is the correct one.

*Meliceritites haimeana* D'Orbigny, 1851.
*Meliceritites semiclausa* Gregory, 1899.
*Meliceritites transversa*, new species.
*Microecia (Proboscina) cornucopia* D'Orbigny, 1851.
*Multicrescis mammilosa*, new species.
*Multigalea canui* Gregory, 1909.
*Multigalea marginata*, new species.
*Neuropora micropora*, new species.
*Neuropora tenuinervosa*, new species.
*Neuroporella hemispherica*, new species.
*Notoplagioecia faringdonensis*, new species
*Plethopora aptensis*, new species.
*Proboscina coarctata*, new species
*Proboscina depressa* D'Orbigny, 1851
*Proboscina radiolitorum* D'Orbigny, 1851.
*Proboscina ricordeauana* D'Orbigny, 1853.
*Proboscina virgula* D'Orbigny, 1851.
*Proboscina zic-zac* D'Orbigny, 1851.
*Radiopora tuberculata* D'Orbigny, 1850.
*Reptoclausa denticulata*, new species.
*Reptoclausa hagenowi* Sharpe, 1854.
*Reptomulticava fungiformis* Gregory, 1909.
*Seminodicrescis nodosa* D'Orbigny, 1854.
*Siphodictyum gracile* Lonsdale, 1849.
*Siphodictyum irregulare*, new species.
*Sparsicavea irregularis* D'Orbigny, 1851.
*Stomatopora calypso* D'Orbigny, 1850.
*Tholopora virgulosa* Gregory, 1909.
*Tretocycloecia densa*, new species.
*Tretocycloecia multiporosa*, new species.

### LOWER CRETACEOUS (VALANGIAN) SAINTE-CROIX, SWITZERLAND

*Actinopora stellata* Koch and Dunker, 1837.
*Berenicea confluens* Reuss, 1846.
*Berenicea flabelliformis* Roemer, 1839.
*Berenicea gracilis* Milne-Edwards, 1838.
*Berenicea pulchella* De Loriol, 1863.
*Cardioecia hyselyi* De Loriol, 1869.
*Cardioecia neocomiensis* D'Orbigny, 1853.
*Cardioecia verticellata*, new species.
*Cardioecia verticellata*, var. *entalophoroides*, new variety.
*Ceriocava grandipora*, new species.
*Ceriocava ingens*, new species.
*Ceriocava multilamellosa*, new species.
*Ceriocava junctata*, new species.
*Ceriocava tenuirama*, new species.
*Ceriopora aequipedis*, new species.
*Ceriopora angustipedis*, new species.
*Ceriopora fallax*, new species.
*Ceriopora lobifera*, new species.
*Ceriopora nummularia*, new species.
*Ceriopora ovoidea*, new species.
*Ceriopora parvipora*, new species.

*Ceriopora solida*, new species.
*Ceriopora spongioides*, new species.
*Ceriopora tenuis*, new species.
*Chartecytis compressa*, new species.
*Corymbopora neocomiensis* D'Orbigny, 1854.
*Cyrtopora campicheana* D'Orbigny, 1853.
*Defranciopora neocomiensis*, new species.
*Diplocava globulosa*, new species.
*Diplocava incondita*, new species.
*Diplocava inordinata*, new species.
*Diplocava orbiculifera*, new species.
*Fasciculipora flabellata* D'Orbigny, 1853.
*Leiosoecia aequiporosa*, new species.
*Leiosoecia constanti* D'Orbigny, 1850.
*Leiosoecia grandipora*, new species.
*Leiosoecia proxima*, new species.
*Mecynoecia icaunensis* D'Orbigny, 1850.
*Mecynoecia verticillata* Goldfuss, 1827.
*Mesenteripora marginata* D'Orbigny, 1853.
*Microecia cornucopia* D'Orbigny, 1857.
*Multicrescis* (*Acanthopora*) *formosa*, new species.
*Multicrescis galaefera*, new species.
*Multicrescis lamellosa*, new species.
*Multicrescis landrioti* Michelin, 1841.
*Multicrescis parvipora*, new species.
*Multicrescis pulchella*, new species.
*Multicrescis tuberosa* Roemer, 1839.
*Multifascigera campicheana* D'Orbigny, 1853.
*Multitubigera campicheana* D'Orbigny, 1853.
*Nematifera acuta* D'Orbigny, 1853.
*Nematifera incrustans*, new species.
*Nematifera reticuloides*, new species.
*Nematifera reticulata* D'Orbigny, 1853.
*Neuropora arbuscula*, new species.
*Neuropora ramosa*, new species.
*Proboscina crassa* Roemer, 1839.
*Proboscina toucasiana* D'Orbigny, 1851.
*Proboscina zic-zac* D'Orbigny, 1851.
*Radiofascigera ramosa* D'Orbigny, 1853.
*Reptoclausa meandrina* De Loriol, 1868.
*Reptoclausa neocomiensis* D'Orbigny, 1853.
*Reptomulticava bellula* De Loriol, 1869.
*Retenoa campicheana* D'Orbigny, 1853.
*Spinopora neocomiensis*, new species.
*Spiroclausa neocomiensis* De Loriol, 1863.
*Stomatopora filiformis* De Loriol, 1863.
*Stomatopora granulata*, var. *neocomiensis*, new variety.
*Trigonoecia haimeana* De Loriol, 1863.
*Trigonoecia* (*Mesenteripora*) *neocomiensis* D'Orbigny, 1853.
*Trigonoecia semota*, new species.
*Trigonoecia tubulosa* D'Orbigny, 1850.
*Zonopora arborea* Koch and Dunker, 1837.
*Zonopora compressa*, new species.

# Order CYCLOSTOMATA Busk

## Division INOVICELLATA

## Family DIASTOPORIDAE Gregory, 1899

### Forma STOMATOPORA Bronn, 1825

### STOMATOPORA CALYPSO D'Orbigny, 1850

Plate 26, fig. 11

1899. *Stomatopora calypso* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 19, pl. 1, figs. 8, 9. (Bibliography, geological distribution.)

Our specimen approaches, in its small oral dimensions, Figure 9 of Gregory, 1899, which represents a specimen from the Albian of Hunstanton. Here the aperture measures only 0.10 mm. in diameter.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotype.*—Cat. No. 69829, U.S.N.M.

### STOMATOPORA FILIFORMIS De Loriol, 1863

1863. *Stomatopora filiformis* DE LORIOL, Les invertébrés du Néocomien inférieur du Mont Salève, p. 132, pl. 16, figs. 6, 7.

*Measurements.*—Diameter of orifice, 0.08 by 0.10 mm. (0.07–0.10 mm.); diameter of peristome, 0.12 mm.; diameter of zooecium, 0.14 mm. (0.15–0.17 mm.); length of zooecium, 0.56–0.60 mm. (0.50–0.70 mm.). The Sainte Croix specimens are mediocre, and we have based our determination on a good specimen from the Canu collection, in which the orifice is elliptical. The measurements in parentheses are the extremes shown on specimens from the Geneva Museum determined by De Loriol.

*Occurrence.*—Lower Cretaceous: Mont Salève, near Geneva (Hautervian) and Sainte Croix (Valangian), Switzerland.

Cat. No. 69830, U.S.N.M.

### STOMATOPORA GRANULATA, var. NEOCOMIENSIS, new variety

1838. *Alecto granulata* MILNE EDWARDS, Mémoire sur les Crisies, Annales Sciences naturelles, vol. 9, p. 205, pl. 16, fig. 3.

1853. *Stomatopora granulata* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 836, pl. 628, figs. 5–8.

1868. *Stomatopora granulata* DE LORIOL, Monographie des couches de etage Valangien d'Arzier (Vaud), Paléontologie Suisse, ser. 4, pl. 5, fig. 12.

Gregory, 1899 (p. 3), published a long synonomy of this species, in which the geological occurrence is also equally great. This does not seem to us perfectly exact and we prefer to form a special variety for the Lower Cretaceous specimens corresponding to the figures of Milne Edwards and of D'Orbigny.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of zooecium, 0.30 mm.; length of zooecium, 0.70 mm.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland. The authors have noted this species at Arzier (Vaud), at Vassy (Haute Marne), Les Saints-en-Puisaye and Les Croûtes (Yonne), and Morteau (Doubs), France.

Cat. No. 69831, U.S.N.M.

### Genus CELLULIPORA D'Orbigny, 1849

1849. *Cellulipora* D'Orbigny, Description de quelques genres nouveaux de Mollusques bryozoaires, Revue et Magazin de Zoologie, ser. 2, vol. 1, p. 500.

### CELLULIPORA SPISSA Gregory, 1899

Plate 26, figs. 8, 9

1899. *Berenicea spissa* Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 108, pl. 7, fig. 4.

Gregory, 1899, wrote: "The name of the species refers to the thick form of the zoarium, but the most interesting feature of this bryozoan is its tendency to grow in a series of zoarial groups, as if it were a very primitive form of *Cellulipora.*"

There is no reason to separate this species from the group *Cellulipora,* the exterior aspect being absolutely identical; the cellules are very short and cylindrical.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England, and Ervy, Switzerland.

*Plesiotype.*—Cat. No. 69832, U.S.N.M.

### Forma PROBOSCINA Audouin, 1826

### PROBOSCINA TOUCASIANA D'Orbigny, 1853

Plate 26, fig. 10

1853. *Proboscina toucasiana* D'Orbigny, Paléontologie française, Terrain Crétacé, vol. 5, p. 856, pl. 634, figs. 5, 6.

Gregory, in 1899, identified this species with *Proboscina fasciculata* Reuss, 1845. This is possible, and we refer the reader to page 29 of his catalogue for the synonomy and geological distribution. However, it differs from *Proboscina zic-zac* D'Orbigny, 1851. Our specimens correspond to the figure given by D'Orbigny and we therefore cite only this reference.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69833, U.S.N.M.

### PROBOSCINA CRASSA Roemer, 1839

Plate 27, fig. 3

1853. *Proboscina crassa* D'Orbigny, Paléontologie française, Terrain Crétacé, vol. 5, p. 848, pl. 631, figs. 9–11 (*divaricata*).

1899. *Proboscina crassa* Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 34. (Bibliography and geologic distribution.)

From our study of the Sainte-Croix specimens we have observed:

(1) The variety *alectodes* Gregory, 1899 (p. 38), known hitherto only from the Upper Cretaceous, is now recognized in the Lower Cretaceous by specimens indicating it is only one of the zoarial forms.

(2) A specimen was noted expanded almost into the *Berenicea* growth form, as in the variety *elevata* Gregory, 1899, from the Lower Cretaceous.

(3) Another specimen corresponds rigorously to the figure published by D'Orbigny.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland, Censeau (Doubs), Villers-le-lac (Jura), and Berklingen (Germaine), France.

*Plesiotype.*—Cat. No. 69834, U.S.N.M.

### PROBOSCINA RADIOLITORUM D'Orbigny, 1851

Plate 27, figs. 1, 2

1899. *Proboscina radiolitorum* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 48, pl. 3, fig. 5. (Bibliography, geological distribution.)

The figured specimen is incrusting a sponge. Although this species is easy to determine, it has not hitherto been observed in the Lower Cretaceous.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotype.*—Cat. No. 69835, U.S.N.M.

### PROBOSCINA ZIC-ZAC D'Orbigny, 1853

Plate 29, fig. 7

1853. *Proboscina zic-zac* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 847. pl. 631, figs. 6, 7.

*Measurements.*—Diameter of orifice, 0.08 mm.; diameter of peristome, 0.16 mm.; length of zooecium, 0.32–0.40 mm. It seems to us that Gregory is in error in identifying this species with *Proboscina fasciculata* Reuss. The micrometric dimensions are different.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Geological distribution.*—Lower Cretaceous (Neocomian): Vassy (Haute Marne), France, and Sainte-Croix (Vaud), Switzerland (D'Orbigny).

*Plesiotype.*—Cat. No. 69840, U.S.N.M.

### PROBOSCINA RICORDEAUANA D'Orbigny, 1853

Plate 27, figs. 7, 8

1853. *Proboscina ricordeauana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 850, pl. 750, fig. 6.

The specimen which we illustrate seems to agree very well with the one figured by D'Orbigny. It incrusts a sponge.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Geological distribution.*—Lower Cretaceous (Aptian): Les Croutes, Gurgy, France (D'Orbigny).

*Plesiotype.*—Cat. No. 69836, U.S.N.M.

### PROBOSCINA VIRGULA D'Orbigny, 1853

Plate 27, figs. 9, 10

1853. *Reptotubigera virgula* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 753, pl. 631, figs. 15–17.

*Measurements.*—Diameter of orifice, 0.06 mm.; diameter of peristome, 0.08 mm.; distance of orifices, 0.32–0.40 mm. The peristomes are not grouped in bundles, and we are ignorant of D'Orbigny's reason for classifying this species in his genus *Reptotubigera.*

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Geological distribution.*—Cenomanian: Le Mans (Sarthe), France.

*Plesiotype.*—Cat. No. 69837, U.S.N.M.

### PROBOSCINA DEPRESSA D'Orbigny, 1853

Plate 27, figs. 5, 6

1853. *Proboscina depressa* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 849, pl. 631, figs. 12–14.

*Measurements.*—Diameter of orifice, 0.08 mm.; diameter of peristome, 0.10–0.12 mm.; diameter of zooecium, 0.14 mm.; distance of orifices, 0.48–0.60 mm. The fine specimen here figured incrusts a sponge. It corresponds very well to D'Orbigny's description and figure.

The type preserved in the Museum of Paris is worn, according to Pergens, 1889. With our new illustration we are able to maintain D'Orbigny's species.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Geological distribution.*—Lower Cretacous (Neocomian): Vassy and Nozeroy, France (D'Orbigny).

*Plesiotype.*—Cat. No. 69843, U.S.N.M.

### PROBOSCINA COARCTATA, new species

Plate 28, fig. 1

*Description.*—The zoarium encrusts shells. It is formed of diverging, ramified fronds, each of which is claviform, much narrowed at the base and *contracted* in its inferior third; the surface is covered with large overlapping, concentric wrinkles. The tubes are invisible. The peristomes are very salient, thin, and much scattered.

*Measurements.*—Diameter of orifice, 0.035 mm.; diameter of peristome, 0.08 mm.; distance of peristomes, 0.40–0.80 mm.; separation of peristomes, 0.40 mm. The distance and separation of the peristomes are quite variable. The submedian contraction of the fronds very well characterizes this species.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69000, U.S.N.M.

### Forma BERENICEA Lamouroux, 1821

#### BERENICEA FLABELLIFORMIS Roemer, 1839

1839. *Aulopora flabelliformis* ROEMER, Die Versteinerungen des Norddeutschen Oolithen-Gebirges, App., p. 15, pl. 17, fig. 4.

1840. *Rosacilla flabelliformis* ROEMER, Die Versteinerungen der Norddeutschen Kreidegebirges, p. 19.

1863. *Berenicea flabelliformis* DE LORIOL, Les Invertébrés du Neocomian inférieur du Mont Salève près Genève, p. 134, pl. 17, fig. 2.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of tubes, 0.18–0.20 mm.; distance of peristomes, 0.60 mm.; separation of tubes, 0.60 mm.

*Affinities.*—De Loriol's determination was based upon specimens from Germany which still exist in the Museum of Geneva. The type of De Loriol's figure bears transverse wrinkles. In its micrometric dimensions this is an intermediate species between *Berenicea gracilis* Milne-Edwards, 1838, and *Berenicea grandipora,* new species.

*Occurrence.*—Lower Cretaceous (Neocomian): Mont-Salève, near Geneva and at Sainte-Croix (Vaud), Switzerland.

*Geological distribution.*—Neocomian at Shöppenstadt, Hanover, Germany (Roemer).

Cat. No. 69838, U.S.N.M.

#### BERENICEA GRACILIS Milne-Edwards, 1838

1899. *Berenicea gracilis* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, p. 73. (Bibliography and geological distribution.)

*Measurements.*—Diameter of orifice, 0.06–0.07 mm.; diameter of tubes, 0.18 mm.; distance of orifices, 0.50–0.60 mm.

*Affinities.*—From the bibliography given by Gregory it is necessary to eliminate *Aulopora flabelliformis* Roemer, 1839, which is a much larger species.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

Cat. No. 69839, U.S.N.M.

#### BERENICEA CONFLUENS Reuss, 1846

Plate 27, fig. 4

1899. *Berenicea confluens* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 110, pl. 5, fig. 4. (Bibliography and geological distribution.)

*Affinities.*—Our illustrated specimen resembles the one figured by Gregory as a young zoarium which was obtained from the Albian at Cambridge, England. The dimensions of the orifice, 0.10 mm., is in accord with that of Gregory, but the zoarium is only 2 mm. in diameter. In exterior aspect it corresponds still more to *Discosparsa cupula* D'Orbigny, 1852, from the French Turonian, but our zoarium is not free, as it incrusts a shell.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69841, U.S.N.M.

### BERENICEA PARVULA, new species

Plate 28, figs. 8, 9

*Description.*—The zoarium encrusts sponges, in a small flabelliform lamella. The tubes are distinct, very convex, separated by a deep furrow, smooth, very *small*. The peristomes when broken are elliptical but intact are orbicular and oblique, always thin.

*Measurements.*—Diameter of orifice, 0.06 mm.; diameter of tubes, 0.12 mm.; distance of peristomes, 0.32 mm.; separation of peristomes, 0.40 mm.

*Affinities.*—This species is still smaller than *Berenicea gracilis* Milne-Edwards, 1838. It is distinguished again by the rectilinear form of the tubes and by its separation always superior to the distance.

The convexity of the tubes, the flabellate arrangement, the great saliency of the peristome, and the still smaller zooecial dimensions do not permit confusion with *Berenicea pulchella* De Loriol, 1863.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (very rare).

*Holotype.*—Cat. No. 69842, U.S.N.M.

### BERENICEA PULCHELLA De Loriol, 1863

Plate 28, fig. 4

1863. *Berenicea pulchella* De Loriol, Les invertébrés du Neocomien inférieur du Mont Salève pres Genève, p. 135, pl. 16, fig. 9.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of tubes, 0.16 mm.; distance of peristomes, 0.40–0.48 mm.; separation of peristomes, 0.48 mm.

*Affinities.*—The type at the Museum of Geneva is not very well preserved; our determination, based solely on the small micrometric measurements, is therefore a little doubtful. The studied specimens were incrusting *Meliceritites*.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (very rare). Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69845, U.S.N.M.

### **BERENICEA GRANDIPORA, new species**

Plate 28, figs. 2, 3

*Description.*—The zoarium encrusts sponges. The tubes are arranged in fan-shape around the ancestrula and form an irregularly discoid colony; they are visible, convex, separated by a furrow, somewhat wrinkled transversely, and often swollen in their median part. The peristome is orbicular, thin, little salient.

*Measurements.*—Diameter of orifice, 0.12–0.15 mm.; diameter of peristome, 0.24 mm.; diameter of tubes, 0.32 mm.; distance of tubes, 0.66 mm.; separation of tubes, 1 mm.

*Affinities.*—Gregory, 1899, has figured from the Aptian of the Isle of Wight (pl. 5, fig. 1) under the erroneous name of *Berenicea gracilis* Milne-Edwards, 1838, a specimen in which the dimensions are very close to our species and which could indeed be the same species. This species has much larger micrometric dimensions than *Berenicea gracilis* Milne-Edwards, 1838, and *Berenicea flabelliformis* Roemer, 1839, which Gregory incorrectly identified with *B. gracilis*

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69846, U.S.N.M.

### **BERENICEA FARINGDONENSIS, new species**

Plate 29, figs. 5, 6

*Description.*—The zoarium encrusts sponges in lamellae with irregular edges. The tubes are indistinct, smooth, somewhat convex. The peristome is thick, salient, perpendicular to the zooecial plane, orbicular.

*Measurements.*—Diameter of orifice, 0.15–0.16 mm.; diameter of peristome, 0.20 mm.; distance of peristomes, 0.70–0.80 mm.; separation of peristomes, 0.60–0.64 mm.

*Affinities.*—This large species differs from *Berenicea grandipora* new species in the irregular arrangements of its peristomes and in its indistinct tubes.

In exterior aspect it resembles *Diastopora neocomiensis* De Loriol, 1863, but differs in its incrusting zoarium and its much larger dimensions.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69847, U.S.N.M.

### **BERENICEA FILIFERA, new species**

Plate 29, figs 3, 4

*Description.*—The zoarium encrusts sponges in thin and irregular lamellae. The tubes are arranged in quincunx, much scattered; they are distinct, separated by a salient thread, concave in the longitudinal direction; the frontal is ornamented with small salient interrupted, longitudinal *threads*. The peristome is orbicular, thick, salient, perpendicular to the zooecial plane.

*Measurements.*—Diameter of orifice, 0.12–0.13 mm.; diameter of peristome, 0.17 mm.; diameter of tubes, 0.24–0.30 mm.; distance of peristomes, 0.60–0.70 mm.; separation of peristomes, 0.80 mm.

*Affinities.*—This species is very well characterized not only by its concave tubes but also by its frontal ornamentation and especially by its small salient threads arranged in quincunx.

*Occurence.*—Lower Cretaceous (Aptian): Faringdon, England (very rare).

*Holotype.*—Cat. No. 69848, U.S.N.M.

### BERENICEA (REPTOMULTISPARSA) TENELLA De Loriol, 1868

Plate 29, figs. 1, 2

1868. *Reptomultisparsa tenella* De Loriol, Monographie des Couches de l'etage Valangien d'Arzier (Vaud), Paléontologie Suisse, ser. 4, vol. 2, p. 61, pl. 5, figs. 15, 16.

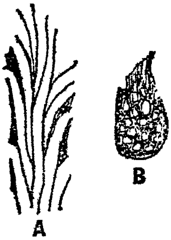


FIG. 1.—*Clinopora quadripartita*, new species. A, B. Longitudinal and transverse sections, × 16. Lower Cretaceous (Aptian): Faringdon, England

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of peristome, 0.12 mm.; distance of tubes, 0.34 mm.; separation of peristomes, 0.40 mm.

*Affinities.*—The figured specimen is not in the *Reptomultis parsa* form of growth but is an irregular *Berenicea;* it encrusts a sponge. The zone of growth is not visible. The exterior aspect of the tubes is that of the figure of De Loriol, but this author has never given the micrometric measurements. Our determination remains therefore doubtful.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotype.*—Cat. No. 69849, U.S.N.M.

### Genus CLINOPORA Marsson, 1877

1877. *Clinopora* Marsson, Die Bryozoen der weissen Schreibkreide der Insel Rügen, Palaeontologische Abhandlungen, vol. 4, p. 24.

This genus is still little understood. The published sections are not in accord, and those which we give are still somewhat different. We have not been fortunate enough to discover the ovicell. The anastomosing lines which ornament the surface and form the chief generic characterictic seem to correspond only to parietal thickenings.

*Genotype.*—*Clinopora* (*Entalophora*) *lineata* Beissel, 1865, Cretaceous.

### CLINOPORA QUADRIPARTITA, new species

Plate 29, figs. 8–11

*Description.*—The zoarium is free, cylindrical, bifurcated in the same plane. The tubes are visible, separated by salient threads divided into *four parts* by other anastomosing threads. The orifice is orbicular or elliptical. The peristomes are somewhat salient, thin, scattered, arranged in quincunx.

*Measurements.*—Diameter of orifices, 0.14 mm.; diameter of peristomes, 0.20 mm.; diameter of branches, 0.75 mm.

*Structure.*—In transverse section the tubes are polygonal, equal, with adjacent and very thick walls. In longitudinal sections the tubes are cylindrical, with axial gemmation. The thickening of the walls seems to correspond to the salient threads of the exterior surface. The sectioned specimen was very small and did not permit of better observations.

This species differs from *Clinopora striatopora* Vine, 1885, from the Albian of Cambridge, England, by its much smaller micrometric measurements and very different arrangement of its salient threads.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69852, U.S.N.M.

## Family HETEROPORIDAE Pergens and Meunier, 1886

### Genus HETEROPORA Blainville, 1830

### HETEROPORA NUMMULARIA, new species

Plate 20, figs. 6–8

*Description.*—The zoarium is free, *discoid,* little convex, unilamellar, ornamented with feeble tuberosities. The apertures are orbicular, arranged in quincunx, placed at the bottom of a small infundibuliform cavity. The mesopores are small, irregular, polygonal, widely spaced.

*Measurements.*—Diameter of aperture, 0.08 mm.; diameter of mesopores, 0.04 mm.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69853, U.S.N.M.

### Genus MULTICRESCIS D'Orbigny, 1852

### MULTICRESCIS TUBEROSA Roemer, 1839

1909. *Multicrescis tuberosa* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 205, figs. 52–54, pl. 9, fig. 4. (Bibliography and geological distribution.)

Our specimen corresponds exactly to Gregory's figure, so that a new figure is unnecessary. Canu, in 1902, has noted the occurrence of this species at Sainte-Croix.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

### MULTICRESCIS GALAEFERA, new species

Plate 21, figs. 1–4

*Description.*—The zoarium is large, massive, subcylindrical, hollow at the base, solid at the summit, multilamellar. The orifices are polygonal or subcircular, oblique, ornamented by a very short and irregularly placed visor. The mesopores are polygonal, somewhat smaller than the apertures.

*Measurements.*—Diameter of aperture, 0.08 mm.; diameter of mesopores, 0.06 mm.; dimensions of zoarium, 2.5 by1.5 mm.

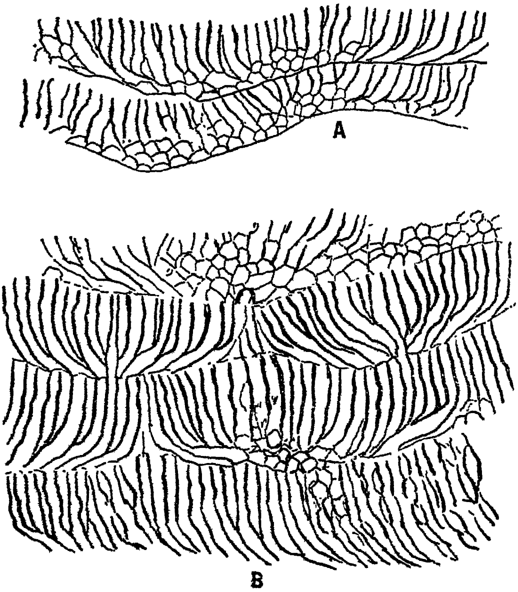


FIG. 2.—Genus *Multicrescis* D'Orbigny, 1881. A. *Multicrescis lamellosa*, new species. Portion of a transverse section, × 16, with two lamellae. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. B. *Multicrescis galaefera*, new species. Meridian section, × 16. The subcolonies grow from a lateral tube of an inferior subcolony. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Structure.*—Very probably *Multicrescis*, provided with visors, as in the present species, belong to the family Lichenoporidae, but in the absence of ovicells we prefer to preserve the zoarial classification.

The longitudinal section shows that the lamellae are formed by orbicular subcolonies united laterally. Each of them arises from the development of a lateral tube of an inferior subcolony. The tubes acylindrical, with dorsal gemmation and with thickened walls. The mesopores are numerous and of unequal length.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69854, U.S.N.M., and Museum Comparative Zoology.

### MULTICRESCIS PARVIPORA, new species

Plate 20, figs. 9–11

*Description.*—The zoarium is globular, borne on a narrow base, formed of many completely enveloping lamellae. The orifices are *very small*, arranged in quincunx, ornamented with a very small irregular visor. The mesopores are very small, polygonal, arranged quite irregularly.

*Measurements.*—Diameter of apertures, 0.04 mm.; diameter of mesopores, 0.03 mm.; diameter of zoarium, 7 mm.

*Structure.*—The meridian section shows cylindrical tubes with solid thickened walls. The lamellae are formed by orbicular subcolonies invisible externally. The epithecal lines are thin and rare. The basal lamellae are thick. The mesopores are long and of little diameter; they are only visible in the portions where the subcolonies are cut in the same axis as their initial cell.

*Affinities.*—This species differs from *Multicrescis galaefera* in its still smaller micrometric measurements and its globular and smaller zoarium.

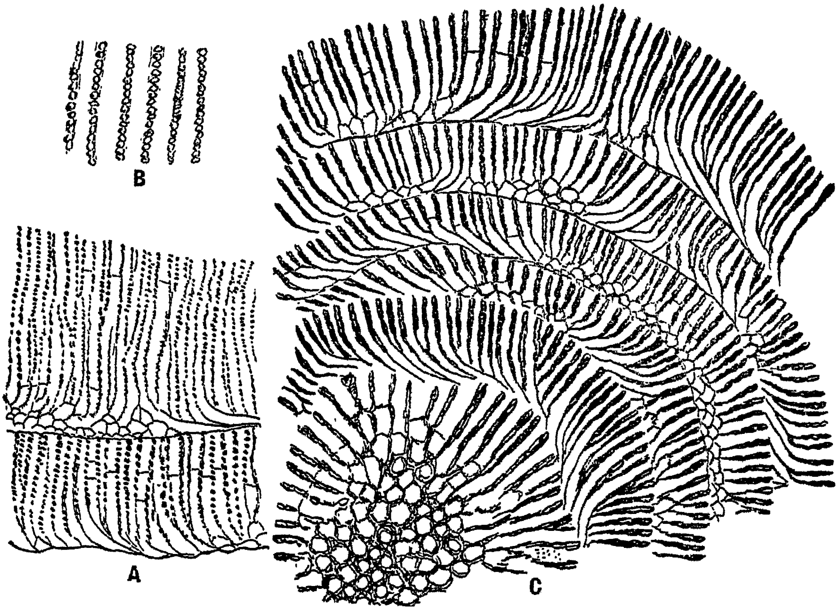


FIG. 3.—Genus *Multicrescis* D'Orbigny, 1852. A, B. *Multicrescis landrioti* Michelin, 1841. A. Portion of a meridian section, × 16, showing two superposed lamellae. B. Sketch, × 30, exhibiting annular structure of the tubes. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. C. *Multicrescis parvipora*, new species. Meridian section, × 16. The tubes of the enveloping lamellae are perpendicular to the tubes of the primitive zoarium. Each lamella is formed of a variable number of subcolonies. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

It differs from *Reptomulticava fungiformis*, Gregory, 1909, from Faringdon, England, in its much smaller zoarium and in the presence of small visors on the tubes.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69855, U.S.N.M., and Museum Comparative Zoology.

### MULTICRESCIS (?) LANDRIOTI Michelin, 1841

Plate 20, figs. 12–15

1909. *Semimulticavea landrioti* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 242. (Bibliography.)

*Measurements.*—Diameter of apertures, 0.08 mm.; diameter of mesopores, 0.06 mm.; diameter of zoarium, 2.5 by 1.5 cm.

*Structure.*—The zoarial base is an epitheca concentrically wrinkled flat, or concave. Some zoaria completely surround small shells.

Exteriorly there are no subcolonies visible, as in D'Orbigny's figure, so that our determination of the species, made according to zoarial analogies, is doubtful. We know, however, that this character disappears easily upon the least superficial alteration.

In meridian section the tubes are cylindrical and the mesopores of variable length. The tubes are annular and their walls vesicular. The small parietal vesicles correspond to the successive annuli of the tubes. The subcolonies are clearly outlined by their initial tubes.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Plesiotypes.*—Cat. No. 69856, U.S.N.M.

### MULTICRESCIS LAMELLOSA; new species

Plate 21, figs. 7–9

*Description.*—The zoarium is free, large, *lamellose,* orbicular, formed of many thin superposed lamellae. The inferior face is wrinkled concentrically. The apertures are polygonal, arranged in irregular quincunx. The mesopores are smaller, polygonal, irregularly placed.

*Measurements.*—Diameter of apertures, 0.12 mm.; diameter of mesopores, 0.08 mm.; zoarial diameter, 2.5 cm.

*Structure.*—The specimen figured is the largest fragment observed; it belonged certainly to a large orbicular colony.

In meridian section the tubes are cylindrical, short, recurved at their extremity. The mesopores are rather short. The walls are entire.

*Affinities.*—In zoarial aspect this species much resembles that which we have called *Multicrescis landrioti* Michelin, 1841, but differs in its greater micrometric dimensions and in sections by the nonannulated tubes.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69857, U.S.N.M., and Museum Comparative Zoology.

### MULTICRESCIS MAMMILLOSA, new species

Plate 21, figs. 5, 6

*Description.*—The zoarium encrusts shells and is formed of many thin superposed lamellae. The orifices are polygonal or suborbicular, arranged in quincunx. The mesopores are few in number, polygonal, smaller than the orifices, irregularly placed. The zoarial surface is mammillose.

*Measurements.*—Diameter of apertures, 0.10 mm.; diameter of mesopores, 0.06 mm.

*Affinities.*—This is a *Multicrescis* in which the tubes have neither visors nor peristomes. We did not have enough specimens to prepare thin sections.

The species differs from *Semimulticavea variolata* Gregory, 1909, in its much smaller micrometric dimensions. It differs from *Heteropora subaequiporosa* Gregory, 1909, in its smaller micrometric measurements and in its zoarium, which is not free.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69860, U.S.N.M.

### MULTICRESCIS PULCHELLA, new species

Plate 21, figs. 13–18

*Description.*—The zoarium is free, subcylindrical, branched, hollow in the interior. The orifices are circular, oblique, arranged in quincunx, ornamented with a tuberose visor placed inferiorily. The mesopores are numerous, polygonal, smaller than the orifices.

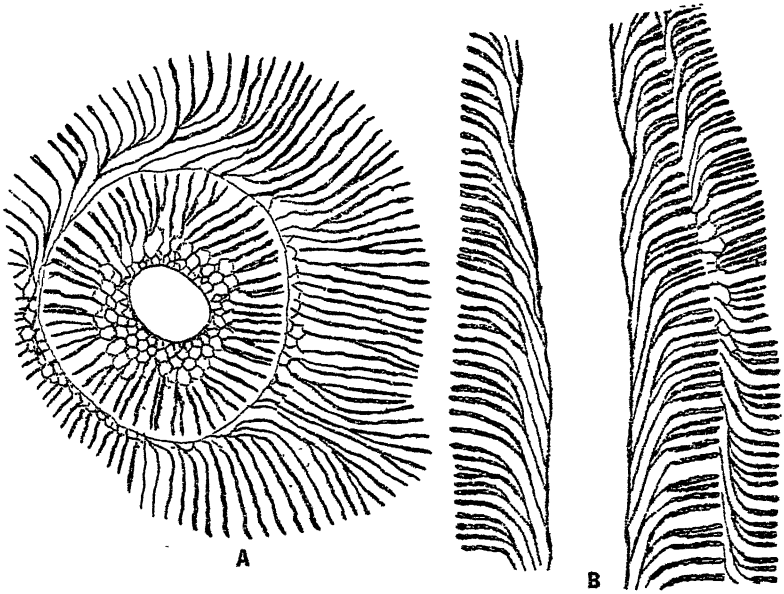


FIG. 4.—*Multicrescis pulchella*, new species. A. Transverse section, × 16, of a hollow zoarium. The external lamella seems to have had only one tube of origin. B. Longitudinal section through the same zoarium, × 16, showing the tube of origin which gave rise to the external lamella. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Measurements.*—Diameter of apertures, 0.06–0.08 mm.; diameter of mesopores, 0.04 mm.

*Structure.*—The zoarial branches are solid at their extremity. When the visors are worn the aspect of the surface is that of an ordinary *Heteropora*. The base is orbicular, little expanded, garnished with a concentrically wrinkled epitheca. The one we figure is not hollow; many lamellae curve about a solid branch, as in *Leiosoecia proxima.*

In longitudinal section the tubes are cylindrical, with dorsal gemmation on a basal lamella; they are much recurved at their extremity. The mesopores are long, numerous, variable in diameter and length. The exterior lamella has its origin in a tube of an internal lamella; the tubes and the mesopores are very much shorter, but they have the same characters as the tubes of the internal lamella.

In transverse section the tubes are polygonal, with thin and adjacent walls. They are much smaller in the vicinity of the basal lamella, which proves that these tubes are club-shaped in their inferior part and cylindrical as soon as they are recurved.

*Affinities.*—This species much resembles *Acanthopora pulchella* De Loriol, 1868. According to the figures of this author, the zoarial surface presents small very regular tuberosities surrounded by radiating mesopores. We have not had occasion to observe the genotype and we understand little of this particular arrangement. We believe that this is a figure somewhat fanciful of a *Multicrescis,* with tuberose visors, like the present species. However, as we are not able to prove this supposition, we will maintain the generic term *Multicrescis.* If by chance it is identical with De Loriol's species the name of the genus would only be changed and all *Multicrescis* with visors would then be *Acanthopora.*

It is to be noted that the exterior lamella appears to have only a single origin. In the other known *Multicrescis* there are alway several points of origin.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69859, U.S.N.M., and Museum Comparative Zoology.

### MULTICRESCIS (ACANTHOPORA) FORMOSA, new species

Plate 21, figs. 10–12

*Affinities.*—Only the figured specimen has been found, and a description is not given, for we have not been able to make thin sections, and on the surface we can not see the difference between the orifice of the tubes and those of the mesopores.

This species has an aspect very close to *Acanthopora pulchella* De Loriol, 1868, but the zoarial tuberosities are here triangular visors diversely oriented, so that it is difficult to discover the pores to which they correspond.

The genus *Acanthopora* D'Orbigny, 1840, differs from *Neuropora* in that the thickened borders of the peristomes present small conical points in place of the elongated veinules (Haime, 1854). The figures given by Haime and by De Loriol, 1868, indicate clearly that the small cones replace a consolidated tube. This is not the case here. More material is necessary in order to establish the nature of the genus *Acanthopora*.

*Occurrence*.—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Holotype*.—Cat. No. 69859, U.S.N.M.

### Genus SEMINODICRESCIS D'Orbigny, 1854

#### SEMINODICRESCIS NODOSA D'Orbigny, 1854

Plate 22, fig. 1

1854. *Seminodicrescis nodosa* D'ORBIGNY, Paléontologie francaise, Terrain Crétacé, vol. 5. p. 1067, pl. 800, figs. 12–14.

Our zoarium is smaller than that figured by D'Orbigny, but the aspect is very much the same. It is hollow and thin at the two extremities. The nodosities do not present any particular character and correspond to the mammillosites of many other species belonging to the genus *Multicrescis* D'Orbigny, 1854. As we have not been able to make any section, we maintain D'Orbigny's name.

*Occurrence*.—Lower Cretaceous (Aptian): Faringdon, England.

*Geologic distribution*.—Lower Cretaceous (Aptian), Saint-Dizier (Haute-Marne), and Les Croûtes (Aube), France (D'Orbigny).

*Plesiotype*.—Cat. No. 69861, U.S.N.M.

### Genus CERIOPORA Goldfuss, 1827

### and

### Genus REPTOMULTICAVA D'Orbigny, 1854

In *Ceriopora* the colonies are unilamellar, more or less massive or lobed, and formed of cylindrical tubes without peristomes and with peripheral gemmation. In *Reptomulticava* the zoaria are multilamellar.

The structure of these genera is not as simple as their diagnoses would indicate. In thin sections they present important peculiarities for observation.

*Zonal lines*.—In longitudinal or meridian sections the zonal lines are curved concentric regular bands of very little width. They are closer together at the summit of the colony than at the base. They do not interrupt the tubes as the diaphragms. They are transformed frequently in a part of their length into basal lamellae supporting not subcolonies but series of tubes differently oriented (*Ceriopora ovoidea*, *C. solida*, *C. lobifera*). This phenomenon is more frequent in the lateral portions of the colonies, where it is manifested externally by the lamellae appearing entirely surrounding the colony (*Ceriopora*) or superposed (*Defranciopora*).

Rarely the zonal lines become transformed into epithecal lines in a portion of their length (*Ceriopora aequipedis*).

A zonal line is formed by divers elements, diaphragms, transverse bands of vesicles, and at the intersection of the zooecial walls by large vesicles with thicker walls. They correspond, therefore, along the entire extent of their length to the tubes contracted and with denser calcification. They may be only potential and manifested only by simultaneous deformations of the tubes (*Defranciopora*).

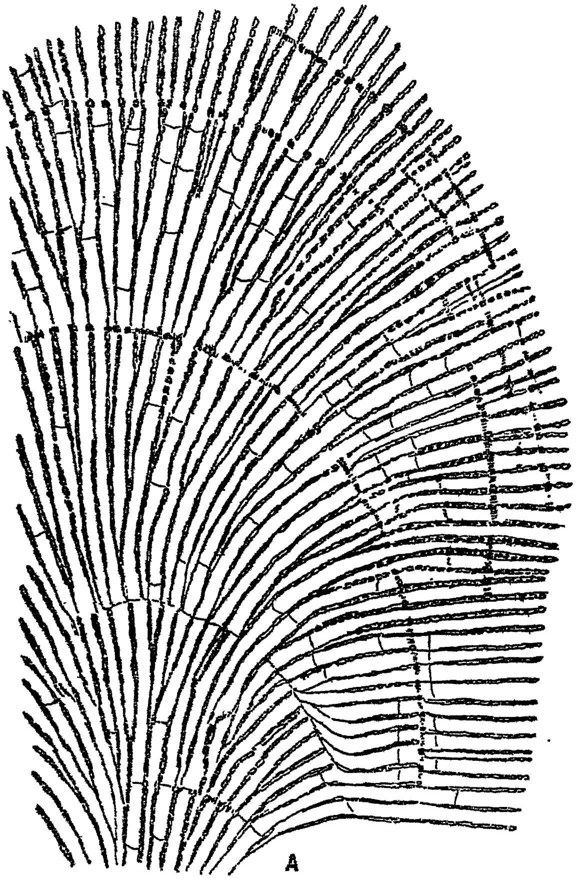


FIG. 5.—*Ceriopora ovoidea*, new species. A. Meridian section, × 16, through a zoarium with definite zonal lines. Lower Cretacious (Valangian): Sainte-Croix, Switzerland

We are ignorant of the significance of the zonal lines. They perhaps correspond to the arrests of growth occasioned by the seasons. Their arrangement in the ensemble of colonial architecture seems to be more a question of mathematics than of biology.

*Zooecial walls.*—The walls of the tubes are very variable in thickness and in structure, characteristics which determine the species. Two different species have always a different vesicular constitution.

They are vesiculose either totally or partially (at the extremity). The vesicles are quite variable in form and in size. When large they give to the walls a moniliform aspect, which reveals sometimes annular tubes. When they are very small the tissue is dense and the preparations are little transparent. Finally, if their distal and proximal walls are thin, the zooecial walls seem then entirely hollow.

The vesicles are very difficult to draw and it is only by photography that they can be figured with fidelity.

In the course of this study we have not paid enough attention to the structure of the zooecial walls not only of the *Ceriopores* but also of many other species described, for in searching for the general laws we have neglected the details. We can affirm that very close study is always necessary because we are convinced that the microscopic structure of the zooecial walls is the best specific character. Good photographs with an enlargement of at least 50 diameters are also necessary.

*Transverse sections.*—The structure of the *Ceriopores* does not differ from that of other cyclostomata, and we have found in transverse sections the characters observed and described hitherto. We have observed (1) polygonal zooecia with thin adjacent walls occurring more often in the central part of the zoarium; (2) round, nonadjacent zooecia, corresponding to the tubes with vesicular walls and with their separation depending upon the thickness of their walls; (3) polygonal zooecia in which the interior is rounded, corresponding to the tubes with walls having many longitudinal rows of vesicles; and (4) tubular zooecia which correspond to the recurved parts of the tubes and are always vesicular.

### CERIOPORA TENUIS, new species

Plate 22, figs. 12–14

*Description.*—The zoarium is very *thin* and encrusts shells. The orifices are polygonal and regular, with walls little thickened.

*Measurements.*—Diameter of apertures, 0.10 mm. Only the figured specimen has been found.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Holotype*—Cat. No. 69862, U.S.N.M.

### CERIOPORA OVOIDEA, new species

Plate 22, figs. 2–5

*Description.*—The zoarium is free *ovoid,* pedunculate, borne on a very small flat base, formed sometimes of lamellae entirely covering the base. The apertures are polygonal and irregular. The zonal lines become transformed in basal lamellae.

*Measurements.*—Diameter of apertures, 0.10 mm.; maximum zoarial width, 9 mm.; zoarial height, 14 mm.

*Structure.*—The zoarial form is rather constant, ovoid or fusiform. On the base, viewed from below, the tubes are arranged fan-shape in the manner of *Berenicea.*

Many of the zoaria appear to be formed of many lamellae inserted one on the other. In reality thin sections show that this is not so for there are no successive complete basal lamellae; sometimes the zonal lines are transformed into basal lamellae but only along a part of their course. This is an arrangement intermediate between that of *Ceriopora* and of typical *Reptomulticava,* so that we do not know into which genus this species as well as most of the following should be placed.

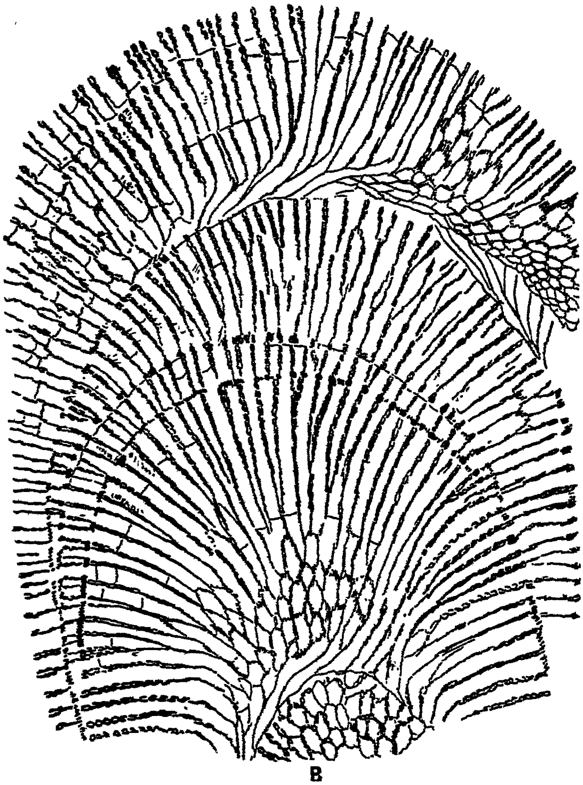


FIG. 6.—*Ceriopora ovoidea,* new species. B. Meridian section of another zoarium, ×16, in which the zonal lines have been transformed into basal lamellae. The main zoarial tubes are oriented in a different direction from those of the primitive zoarium. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

The tubes are cylindrical, with concave diaphragms and with peripheral gemmation. The walls are rather thick, moniliform in a part of their course, and formed of two rows of vesicles in their enlarged portion. The zonal lines are formed by vesicles which are larger and have very thick walls; they become transformed sometimes into true partial basal lamellae. The new tubes arise from a rootlike base and we can suppose that they cover tubes in which the polypide is aborted or diseased and is not able to continue its skeleton with enough of regularity.

*Affinities.*—This species differs from *Ceriopora angustipedis* in its more elongated zoarium, in the smaller diameter of its orifice, and in the presence of false lamellae covering the zoarium.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69863, U.S.N.M.

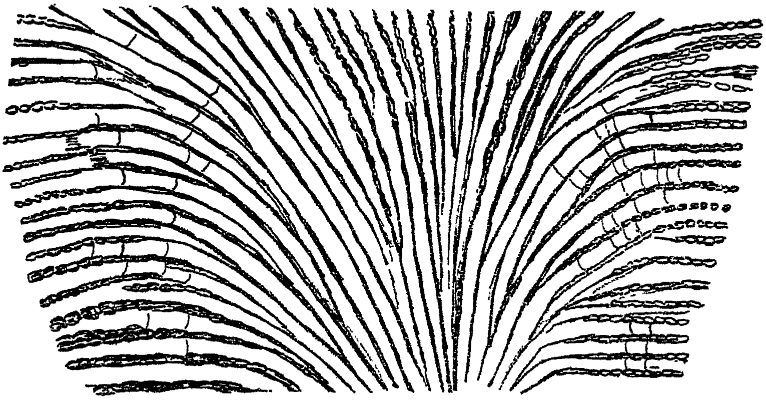


FIG 7.—*Ceriopora angustipedis*, new species. Meridian section, × 16, entirely across a zoarium. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

### CERIOPORA ANGUSTIPEDIS, new species

Plate 22, figs. 15–17

*Description.*—The zoarium is free, globular, with a *narrow* base, somewhat broader than high, entire or apparently covered by lamellae wholly enveloping it. The tubes have thickened walls; the apertures are polygonal and arranged in quincunx. Zonal lines are rare.

*Measurements.*—Diameter of aperture, 0.12 mm.; maximum zoarial width, 9 mm.; maximum zoarial height, 8 mm.

*Structure.*—In meridian section the tubes are cylindrical, with very thick walls; these walls are very finely vesicular but never moniliform; the diaphragms are concave and very irregularly placed. Our sectioned specimen did not show zonal lines very clearly. It is probable that the specimen shown, which exhibits at the base three enveloping lamellae, would in sections show the zonal lines transformed into basal lamellae, as in *Ceriopora ovoidea.*

*Affinities.*—This new species differs from *Ceriopora ovoidea* in its larger aperture (0.12 mm. and not 0.10 mm.), in its zoarium broader than high, and, in section, in the zooecial walls, which are thicker and of different structure.

*Occurrence.*—Lower Cretaceous (Velangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69864, U.S.N.M.

### CERIOPORA AEQUIPEDIS, new species,

Plate 22, figs. 9–11

*Description.*—The zoarium is irregularly hemispherical, generally broader than high, with the base equal to the zoarial width. The orifices are polygonal and the tubes are very thick.

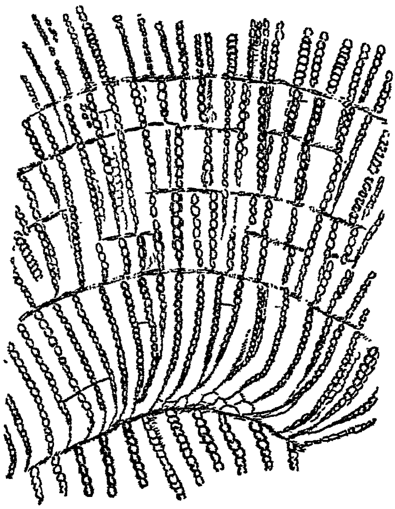


FIG. 8.—*Ceriopora aequipedis*, new species. Meridian section, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Measurements.*—Diameter of aperture, 0.12 mm.; maximum zoarial diameter, 9 mm.; maximum zoarial height, 5 mm.

*Structure.*—In meridian section the tubes are long, cylindrical; the walls are moniliform, with large vesicles. The zonal lines are numerous, very close together, and are transformed partially into basal lamellae.

*Affinities.*—*Ceriopora aequipedis* differs from *C. angustipedis*, in which the diameter of the apertures is identical, in the hemispherical zoarial form, in the unnarrowed base, and, in sections, in the moniliform tubes.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69865, U.S.N.M.

### CERIOPORA SOLIDA, new specie

Plate 22, figs. 6–8

*Descriptions.*—The zoarium is free, *massive*, convex, with a flat or concave base apparently covered by many enveloping lamellae. The tubes have little thickness; the apertures are large, polygonal.

*Measurements.*—Diameter of apertures, 0.16 mm.; zoarial width, 15 mm.; zoarial height, 9 mm.

*Structure.*—In meridian sections the tubes are long, sinuous; the diaphragms are concave and numerous; the zooecial walls are little thickened and are moniliform. The zonal lines are irregular and may be transformed partially into basal lamellae.

*Affinities.*—In its zoarial form this species approaches *Ceriopora aequipedis* but differs in its large zoarium, its much larger aperture (0.16 mm. and not 0.12 mm.), and, in sections, in the irregularity of the zonal lines.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69866, U.S.N.M.

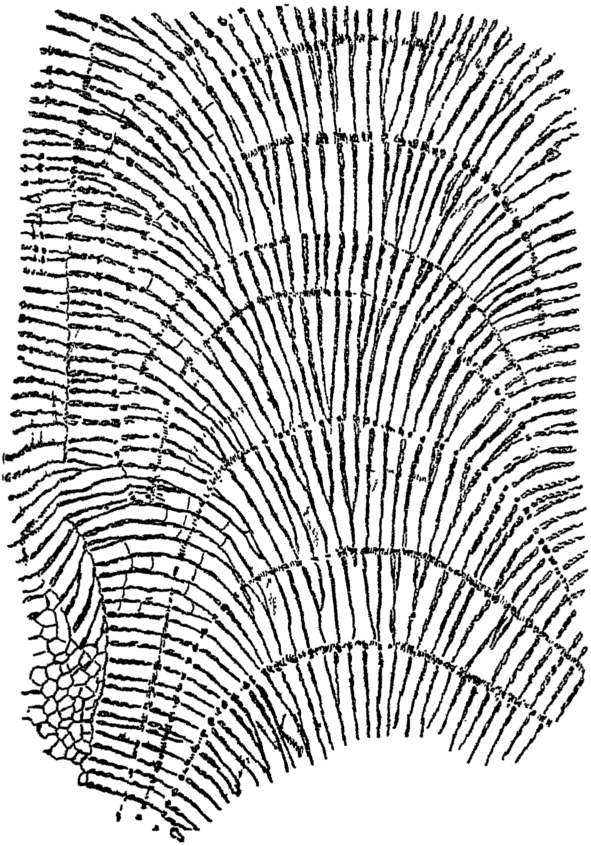


FIG. 9.—*Ceriopora solida*, new species. Meridian section, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

**CERIOPORA PARVIPORA, new species**

Plate 23, figs. 5–7

*Description.*—The zoarium is large, globular, with a concave, narrowed base. There are false enveloping lamellae. The tubes are thick; the apertures are polygonal and irregular.

*Measurements.*—Diameter of aperture, 0.08 mm.; diameter of zoarium, 7 mm.

*Structure.*—The zonal lines are numerous, very close together, formed in large part by diaphragms; they sometimes are transformed into basal lamellae. The walls of the tubes are quite thick and formed of a large number of small orbicular vesicles, arranged frequently in two rows. This structure is more visible in tangential sections, where all the small vesicles are quite visible between the polygonal tubes.

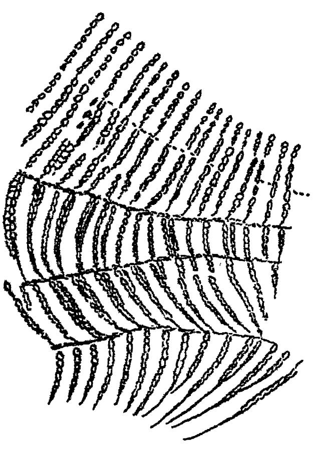


FIG. 10.—*Ceriopora parvipora*, new species. Meridian section, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Affinities.*—In its zoarial form this species is rather close to *Ceriopora aequipedis*, but it differs in its much smaller aperture (0.08 mm. and not 0.12 mm.) and, in sections, in the nonmoniliform zooecial walls.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69867, U.S.N.M.

### CERIOPORA NUMMULARIA, new species

Plate 23, figs. 1–4

*Description.*—The zoarium is free, orbicular or elliptical, *lenticular*, convex, apparently covered over by one or two enveloping lamellae; the base is somewhat concave. The tubes are little thickened; the apertures are polygonal, somewhat oblique, surrounded by very small and irregular tuberosities.

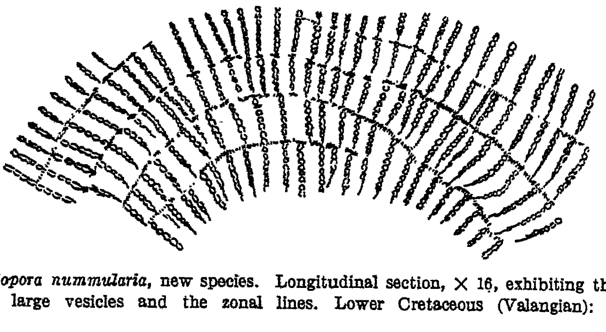


FIG. 11.—*Ceriopora nummularia*, new species. Longitudinal section, × 16, exhibiting the moniliform tubes with large vesicles and the zonal lines. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Measurements.*—Diameter of aperture, 0.14 mm.; diameter of zoarium, 7 mm.

*Structure.*—In meridian section the tubes are cylindrical, with peripheral gemmation; the walls are thin and moniliform. The zonal lines are little separated and formed by calcareous thickenings. Diaphragms are rare.

Our section does not indicate the enveloping false lamellae, but on certain specimens not sectioned these are quite visible.

The zoarial form characterizes this species very well exteriorly.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69868, U.S.N.M.

### CERIOPORA LOBIFERA, new species

Plate 23, figs. 11–17

*Description.*—The zoarium is large, free, subcylindrical; it bears lateral *lobes* more or less developed. The zoarial surface sometimes exhibits small tuberosities. The tubes are thin; the apertures are polygonal and very irregular.

*Measurements.*—Diameter of aperture, 0.12 mm.; diameter of zoarium, 10 mm.; length of large fragments, 25 mm.

*Structure.*—The base is a somewhat expanded disk (fig. 13); the inferior part (fig. 14) shows the characteristic lozenge-shaped tubes recurved at their extremity, radiating around the ancestrula. In thin sections the tubes are cylindrical, recurved at their extremity. The walls are thin and formed of a single row of small vesicles. The zonal lines are widely separated and formed by the thickening of parietal vesicles. The diaphragms are almost always placed on the zonal lines. The latter are transformed into basal lamellae in the inferior part of the colonies.

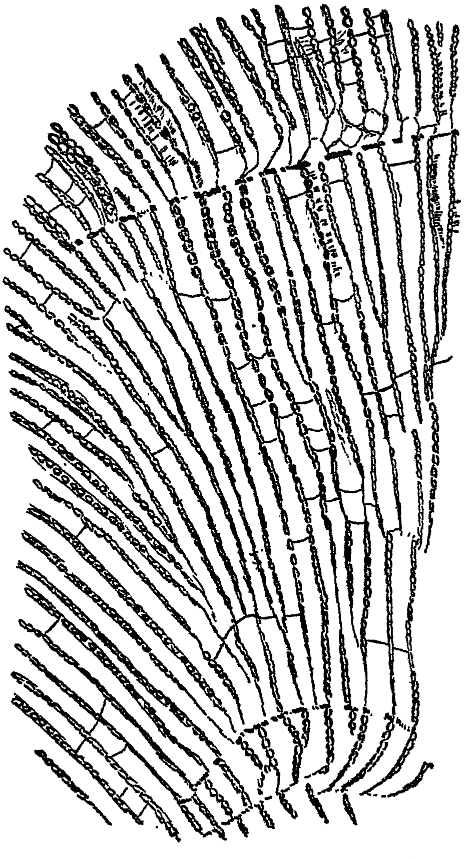


FIG. 12.—*Ceriopora lobifera*, new species. A meridian section, × 16. The zonal lines are transformed sometimes into basal lamellae. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

The arborescent form of this species clearly distinguishes it from all other species from the same locality.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69869, U.S.N.M.

### CERIOPORA FALLAX, new species

Plate 23, figs. 8–10

*Description.*—The zoarium is free, subcylindrical, elongated, apparently formed of many enveloping lamellae. The tubes are thin; the apertures are polygonal, irregular, with heteroporoid aspect.

*Measurements.*—Diameter of large apertures, 0.16 mm.; diameter of small apertures, 0.08–0.12 mm.; diameter of zoarium, 5 mm.

*Structure.*—This species is very *deceiving*. Certain parts of the surface have large and small tubes, as in *Heteropora;* but sections do not show mesopores in the strict sense, for here some shorter tubes or others with a smaller diameter may be seen. The lamellae, visible exteriorly, are not complete and arise by the development of partial basal lamellae.

The zooecial walls are vesicular and moniform; the vesicles are little swollen and their lateral walls only are very thick. Diaphragms exist only at the center of the colony.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

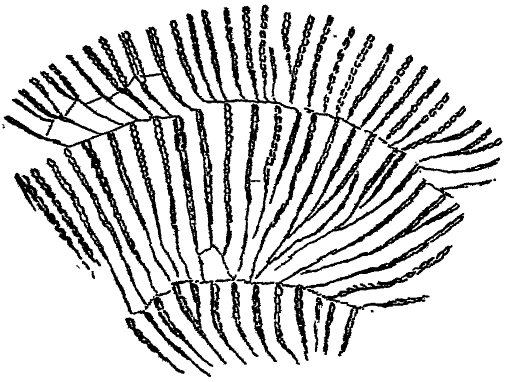


FIG. 13.—*Ceriopora fallax,* new species. A meridian section, × 16. The zonal lines are transformed into basal lamellae. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Cotypes.*—Cat. No. 69870, U.S.N.M.

### CERIOPORA SPONGIOIDES, new species

Plate 24, figs. 7–10

*Description.*—The zoarium is free, subglobular or massive, with a very narrow base. The tubes are thick; the apertures are very irregular and give to the surface the aspect of a calcareous *sponge.*

*Measurements.*—Diameter of orifices, 0.12 mm.; length of zoarium, 12 mm.; height of zoarium, 8 mm.

*Affinities.*—Our sections were not good and we have been unable to study the structure of this fossil. The species differs from *Ceriopora angustipedes* in the aspect of the surface and in its zoaria, which are higher than broad. It differs from *Ceriopora ovoidea* only in the general aspect of the surface, which is of a nature that may represent only alteration in fossilization. We figure traces of ovicells which are possibly those characteristic of *Leiosoecia.*

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotype.*—Cat. No. 69871, U.S.N.M.

### CERIOPORA DIMORPHOCELLA, new species

Plate 24, figs. 1–6; Plate 31, figs 7, 8

*Description.*—The zoarium is free, subcylindrical, with short, lobed branches. The tubes are thick; the apertures are polygonal, with *two* different sizes, and ornamented with very small tongues.

*Measurements.*—Diameter of large apertures, 0.08 mm.; diameter of small apertures, 0.04 mm.; zoarial diameter, 10 mm.; minimum height of fragments, 20 mm.

*Structure.*—The fragments found do not show the base; the colony should be, therefore, rather large and dendroid. An examination of the surface indicates a *Heteropora;* the large apertures are surrounded by smaller ones, which are rather regular in their dimensions. But in meridian sections there are no mesopores; the small orifices correspond to the ordinary tubes, in which the walls are thicker on the zoarial margin. This phenomenon is, moreover, rather irregular, as tangential sections indicate. There are neither diaphragms nor zonal lines.

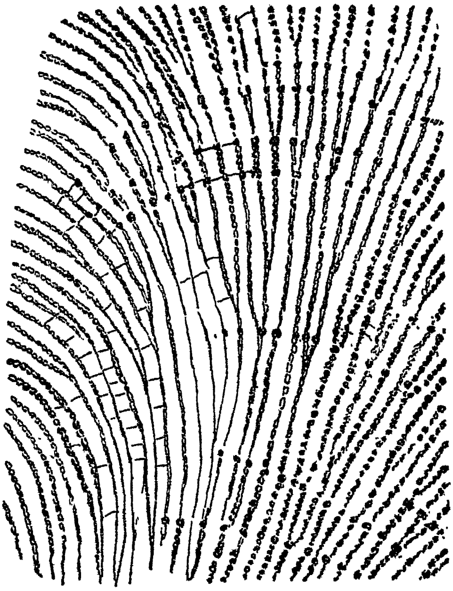


FIG. 14.—*Ceriopora dimorphocella*, new species. Portion of a meridian section, × 16. Lower Cretaceous (Aptian): Faringdon, England

*Affinities.*—This species differs from *Ceriopora fallax* in its much larger zoarium and in its smaller micrometric dimensions.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69872, U.S.N.M.

### REPTOMULTICAVA FUNGIFORMIS Gregory, 1909

Plate 24, figs. 11–17

1909. *Reptomulticava fungiformis* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 135, figs. 38, 39, pl. 7, fig. 6. (Bibliography.)

*Structure.*—Our specimens are much smaller than those in the British Museum, although their appearance is identical. Moreover, the aperture is much smaller (0.10–0.12 mm. and not 0.20 mm.), although its form is similar to that figured by Gregory. Finally, our sections are quite similar to those of the English author. It appears to us impossible to identify otherwise the numerous specimens collected in the same locality, Faringdon.

In meridian section the zoarium appears to be formed by complete, superposed lamellae, with their basal lamella entire. The latter is quite visible on account of a short zone of growth. The zooecial walls are very thick and formed of two or three rows of small vesicles, which, in tangential sections, are very irregular.

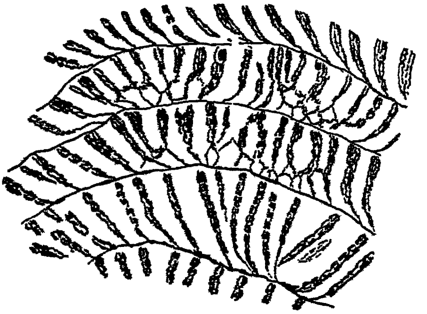


FIG. 15.—*Reptomulticava fungiformis* Gregory, 1909. Meridian section, × 16, showing superposed cellular lamellae, and the thick walls with large vesicles. Lower Cretaceous (Aptian): Faringdon, England

*Affinities.*—In the micrometric dimensions, as well as in sections, our specimens are very close to *Reptomulticava micropora* Roemer, 1839, but they differ in the zoarial form and in the arrangement of the apertures in quincunx.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Plesiotypes.*—Cat. No. 69873, U.S.N.M.

### REPTOMULTICAVA BELLULA De Loriol, 1869

Plate 24, figs. 18–20

1869. *Reptomulticava bellula* DE LORIOL and GILLIERON, Monographie paléontologique et stratigraphique de l'etage Urgonien inferieur de Landeron (Neuchatel), Memoires de la Société helvetique des Sciences naturelles, vol. 23, p. 41; pl. 3, figs. 9–11.

We refer to this species the unique specimen which we have figured, but the micrometric dimensions seem to us a great deal smaller, and there are 25 apertures to the square millimeter in place of 15, as indicated by Gregory.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

## Genus DEFRANCIOPORA Hamm, 1881

### DEFRANCIOPORA NEOCOMIENSIS, new species

Plate 25, figs. 13–15

*Description.*—The zoarium is free, claviform, composed apparently of many discoidal superposed subcolonies. The base is narrower than the zoarium. The tubes are little thickened; the apertures are polygonal and close together.

*Measurements.*—Diameter of aperture, 0.14 mm.; maximum zoarial width, 7 mm.; maximum zoarial height, 10 mm.

*Structure.*—As in the other *Cerioporas* from Sainte-Croix, the exterior aspect of this species is deceiving, for in longitudinal sections the subcolonies are not complete and have a basal lamella only at the periphery of the colony. There are no zonal lines, as in *Ceriopora,* but instead imaginary concentric lines (potential) uniting at the basal lamella and marking the zooecial deformations in a manner that each subcolony seems to have a certain autonomy. This difference of structure from *Ceriopora* justifies the maintenance of the *Defranciopora* Hamm, 1880. Many of the diaphragms bear two tubes. The zooecial walls are moniliform and much expanded at their extremity; the vesicles are very small.

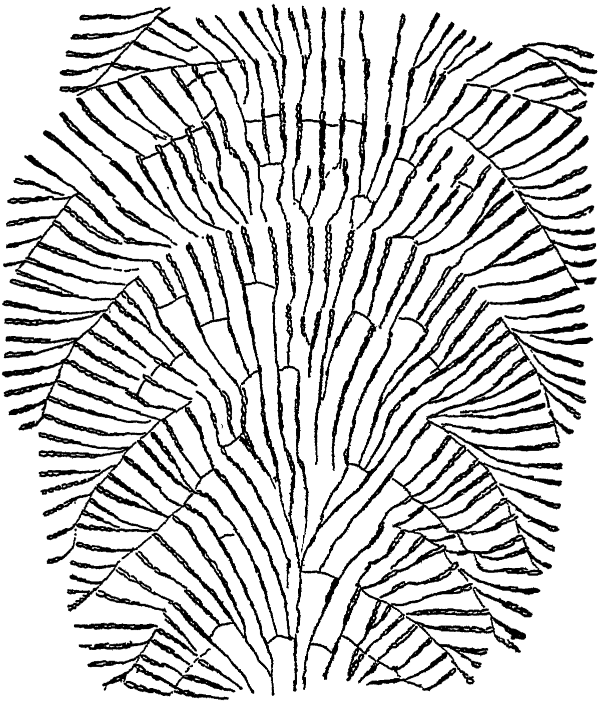


FIG. 16.—*Defranciopora neocomiensis*, new species. Meridian section through a characteristic specimen × 16, with potential zonal lines. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69874, U.S.N.M.

### Genus NEUROPORA Bronn, 1825

1825. *Neuropora* BRONN. Proposed to replace *Chrysaora* Lamouroux, preoccupied by Péron.

The zoarium is free, more or less claviform or arborescent. The surface is traversed by irregular veinules radiating from a special center. The orifices are ornamented with short visors. The tubes are cylindrical, polygonal, crossed by numerous diaphragms; the walls are thick, vesicular, perforated, and united with the visors.

*Genotype.*—*Neuropora conuligera* Hennig, 1893, Cretaceous. The genus was at first referred to the bryozoa; then it was classed among the hydroids, but in 1893 Hennig's study of the genus definitely established its structure. The Lower Cretaceous species are simpler and less well characterized than those of the Upper Cretaceous.

The veinules are formed by solidified tubes. We are ignorant of their physiological function.

### NEUROPORA RAMOSA, new species

Plate 25, figs. 9–12

*Description.*—The zoarium is free, ramose, borne on a very small base, with the branches often pyriform. The orifices are rather large, polygonal, arranged in quincunx, ornamented with tubercles at the angles. The veinules are irregular and converge toward the extremity of the lobes.

*Measurements.*—Diameter of the orifice, 0.12 mm.

*Affinities.*—The form of some zoaria approaches that of typical *Neuropora,* but such specimens are rare. The lobes become elongated generally into veritable branches, although pyriform also. In longitudinal sections the tubular walls are thick, formed by a compact tissue which corresponds to the exterior tubercles. The tubes, solidified and meeting at the point of convergence of the veinules, are somewhat wider than the others. The sections of this species are very opaque and difficult to interpret.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Cotype.*—Cat. No. 69875, U.S.N.M.

### NEUROPORA ARBUSCULA, new species

Plate 25, figs. 1–3

*Description.*—The zoarium is free, cylindrical, *arborescent,* with short branches. The orifices are polygonal, arranged in quincunx, ornamented with a lateral somewhat salient tuberosity. The veinules are irregular and longitudinal.

*Measurements.*—Diameter of orifice, 0.10 mm.; width of zoarium, 6 mm.

*Affinities.*—In the exterior aspect this species is very close to *Neuropora pyriformis,* but it differs in its cylindrical zoarium, its much broader base, and its somewhat smaller zooecial diameter.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Cotype.*—Cat. No. 69876, U.S.N.M.

### NEUROPORA MICROPORA, new species

Plate 25, figs. 4–8; Plate 30, fig. 20

*Description.*—The zoarium is free, hemispherical or pyriform; the base is always narrower. The orifices are very *small*, polygonal, irregular, surrounded by short points. The veinules are rare and irregular.

*Measurements.*—Diameter of orifice, 0.08 mm.; length of large zoaria, 20 mm.

*Structure.*—This species is very well characterized by the smal diameter of its orifices.

The longitudinal section is quite identical with that of the genotype admirably figured by Hennig in 1893. It is quite complicated by the very large number of diaphragms. A certain number of the latter are simultaneous and form a kind of zonal line. The walls are thick and formed by a very finely vesicular tissue. Gemmation is peripheral.

In tangential sections the tubes are polygonal, not adjacent, separated by a vesicular tissue. A second orbicular tube is placed in their interior.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Cotypes.*—Cat. No. 69877, U.S.N.M.

### NEUROPORA TENUINERVOSA, new species

Plate 25, figs. 16–19

*Description.*—The zoarium is free, cylindrical, branched, borne on a base of less diameter. The orifices are small, polygonal, arranged in quincunx, separated by little salient tuberosities. The centers of convergence of the veinules are large smooth, salient tuberosities. The veinules are numerous, *very narrow*, often little visible, arranged in radiating lines around the zoarial tuberosities.

*Measurements.*—Diameter of orifices, 0.06–0.08 mm.; diameter of zoarium, 5 mm.

*Affinities.*—*Neuropora tenuinervosa* differs from *N. micropora* in its branched zoarium and in the presence of salient centers of convergence. It differs from *Neuropora arbuscula* in its smaller orifices, in its less salient visors, and in the presence of salient centers of convergence of the veinules.

The veinules are very narrow, quite transitory, as they disappear upon weathering, so that certain specimens lack them entirely, thus exhibiting the aspect of *Spinopora.*

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69878, U.S.N.M.

### Genus NEUROPORELLA Hennig, 1894

1894. *Neuroporella* HENNIG, Studies öfver Bryozoerna; Sveriges Kritsystem. II Cyclostomata Lunds Universitets Arsskrift, vol. 30, No. 8, p. 26.

The zoarium is formed of irregular incrusting, uni or multi lamellar masses. The centers of convergence of the veinules form smooth salient points. The internal structure is identical with that of *Neuropora*.

*Genotype.*—*Neuroporella ignabergensis* Hennig, 1894. Cretaceous. This genus is only a zoarial form of *Neuropora*, but we maintain it provisionally in order to facilitate determination and because our sections are not numerous enough for a more detailed study.

#### NEUROPORELLA HEMISPHERICA, new species

Plate 26, figs. 1–5; Plate 31, figs. 5, 6

*Description.*—The zoarium is massive, hemispherical, with a concave and somewhat narrower base; it is formed of many superposed lamellae. The orifices are polygonal, separated by small salient tubercules. The veinules are broad, sailient, smooth, and bifurcated.

*Measurements.*—Diameter of orifice, 0.12–0.16 mm.; diameter of large zoarium, 17 mm.

*Affinities.*—This species differs from *Neuroporella ignabergensis* Hennig 1894, in the absence of centers of convergence of the very salient veinules and in its much larger orifices.

In longitudinal sections the tubes are cylindrical with peripheral gemmation, traversed by numerous diaphragms. A large number of the diaphragms are formed simultaneously and form the zonal lines.

In tangential sections the tubes are polygonal and their walls are very thick and opaque.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69879, U.S.N.M.

### Genus SPINOPORA Blainville, 1830

The zoarial surface bears very salient, smooth tuberosities, but veinules are not present. The tubes have internal spines. The orifices and the internal structure are identical with *Neuropora*.

*Genotype.*—*Spinopora* (*Ceriopora*) *mitra* Goldfuss, 1827. Cretaceous. The large tuberosities correspond to the solidified tubes like the centers of convergence in *Neuropora*. This genus appears to us, therefore, as a *Neuroporella* without veinules. The genotype from the Campanian of Sweden and the Island of Rügen is the only species heretofore known.

#### SPINOPORA NEOCOMIENSIS, new species

Plate 26, figs. 6, 7

*Description.*—The zoarium is free, subcylindrical, hollow, branched. The orifices are polygonal, small, arranged in quincunx, separated by very salient tuberosities. The zoarial tubercles are very salient, smooth, much scattered, arranged in quincunx.

*Measurements.*—Diameter of orifices, 0.16 mm.; diameter of zoarium, 4 mm.

*Affinities.*—The zoarial form in this species is very different from that of the genotype, but the external characters are absolutely identical. We have not been able to make sections.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Cotype.*—Cat. No. 69880, U.S.N.M.

# Division OVICELLATA

## Subdivision PARALLELATA Waters, 1887

### Family MECYNOECIIDAE Canu, 1918

#### Genus MECYNOECIA Canu, 1918

#### MECYNOECIA ICAUNENSIS D'Orbigny, 1850

Plate 1, figs. 1–4

1850. *Entalophora icaunensis* D'ORBIGNY, Prodrome de Paléontologie, vol. 2, p. 87.

1853. *Entalophora icaunensis* D'ORBIGNY, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 781, pl. 616, figs. 12–14.

*Measurements.*—

| | Small branches | Large branches | M. proboscidea |
|---|---|---|---|
| | *Mm.* | *Mm.* | *Mm.* |
| Diameter of aperture | 0.16 | 0.12 | 0.16 |
| Diameter of peristome | .24 | .24–.30 | .16–.20 |
| Distance of peristomes | 1.20 (1.76) | 1.20 | 1.20–1.40 |
| Separation of peristomes | .80 | .80 | .30–.40 |

*Affinities.*—This species was identified by Pergens, in 1889 with *Entalophora proboscidea* Milne-Edwards, 1838, and by Gregory, 1899, with *Entalophora virgula* Hagenow, 1840. According to these authors, it begins in the Neocomian and still exists in the recent seas. The Neocomian species appears to us distinct and to differ from the recent species in its more crowded and smoother tubes. We figure a few variations. The structure is identical with that of the recent species and of some Tertiary specimens of which we have published sections in 1920. The transverse section especially is puzzling and we can not explain its structure because the tubes in it are not rounded. This structure is peculiar to this group, and it is little probable that all the species which we have cited as belonging to this genus, because of the nature of the ovicell, have an identical structure.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland, and Censea (Doubs), France.

*Plesiotype.*—Cat. No. 69881, U.S.N.M.

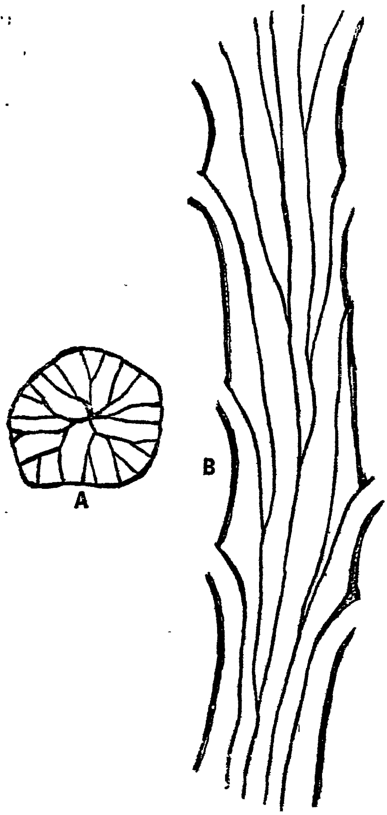


FIG. 17.—*Mecynoecia icaunensis* D'Orbigny, 1850. A–B. Transverse and longitudinal sections, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

### MECYNOECIA (SPIROPORA) VERTICILLATA

Goldfuss, 1827

1850. *Spiropora neocomiensis* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 708, pl. 742, figs. 1, 2.

1865. *Spiropora verticillata* BEISSEL, Ueber die Bryozoen der Aachener Kreidebildung, Naturkundige Verhandelingen Hollandsche Maatschappij der Weltenschappen te Haarlem, ser. 2, vol. 22, p. 70, pl. 8, figs. 91–93.

1869. *Spiropora neocomiensis* DE LORIOL, Monographie de l'etage Urgonien de Landeron, Memoires de la Société helvetique des Sciences naturelles, vol. 23, p. 37, pl. 2, fig. 18.

1909. *Spiropora verticillata* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 256, pl. 11, fig. 5. (Bibliography and geological distribution.)

1922. *Mecynoecia ? verticillata* CANU and BASSLER, Studies on the Cyclostomatous Bryozoa, Proc. U. S. National Museum, vol. 61, p. 13, pl. 1, figs. 16, 17.

*Measurements.*—Diameter of peristome, 0.20–0.24 mm.; distance of verticells, 0.60–0.90 mm. The measurements are identical with specimens from the French Coniacian. In longitudinal section the tubes are cylindrical, with regular peripheral gemmation.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland, etc.

## Genus MICROECIA Canu, 1918

### MICROECIA CORNUCOPIA D'Orbigny, 1851

Plate 28, figs. 5–7

1899. *Proboscina cornucopia* GREGORY, Catalogue of Cretaceous Bryozoa in the British Museum, vol. 1, p. 45, pl. 3, figs. 6, 9, 10; pl. 4, fig. 1. (Bibliography, geological distribution.)

Our specimens from Faringdon found incrusting shells correspond fairly well to Gregory's Figure 6*b*. They do not exhibit the large berenicoid expansions like the type specimen, but they have the same small dimensions.

A specimen from Sainte-Croix appearing to correspond to Figure 1, Plate 4, of Gregory, is ovicelled and belongs to the genus *Microecia.*

*Occurrence.*—Lower Cretaceous: Faringdon, England (Aptian), and Sainte-Croix (Vaud), Switzerland (Valangian).

*Plesiotype.*—Cat. No. 69882, U.S.N.M.

## Genus TRIGONOECIA Canu and Bassler, 1922

### TRIGONOECIA SEMOTA, new species

Plate 1, fig. 5

*Description.*—The zoarium incrusts shells; it is suborbicular, berenicoid; the zone of growth is thin and irregular. The tubes are long, cylindrical, visible, convex, arched; the peristomes are thin, orbicular or elliptical, much *scattered* from each other. The ovicell is elongated or transverse, symmetrical, convex, wrinkled transversely; the oeciostome is small, salient, orbicular, opening on the same plane as the peristomes.

*Measurements.*—Diameter of orifice, 0.14 mm.; diameter of peristome, 0.16–0.18 mm.; distance of peristomes, 0.48–0.64 mm.; separation of peristomes, 0.64–0.72 mm.; diameter of oeciostome, 0.07 mm.; diameter of zoarium, 5 mm.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland (common).

*Holotype.*—Cat. No. 69883, U.S.N.M.

### TRIGONOECIA TUBULOSA D'Orbigny, 1853

Plate 4, figs. 13–15

1853. *Diastopora tubulosa* D'ORBIGNY, Paléontologie française, Terrain Crétacé vol. 5, p. 827, pl. 635, figs. 1–3.

*Measurements.*—Diameter of orifices, 0.09 mm.; diameter of tubes, 0.10 mm.; distance of peristomes, 0.90 mm.; separation of peristomes, 0.50 mm.; diameter of peristome, 0.12–0.14 mm.

*Structure.*—The tubes become dilated in their free terminal portion, so that the diameter of the peristome is greater than that of the tubes. The distance of the peristomes is quite variable. In certain portions the peristomes are very close together and in other places they are grouped in transverse rows.

The ovicell, in its complete form, is a large pyriform quite salient sack, very convex, perfectly symmetrical, and terminated by a very small oeciostome. But it often presents forms less symmetrical in shape. However, it is very rare that on the same specimen of cyclostomatous bryozoan all the ovicells are identical in shape. Irregularity is the rule.

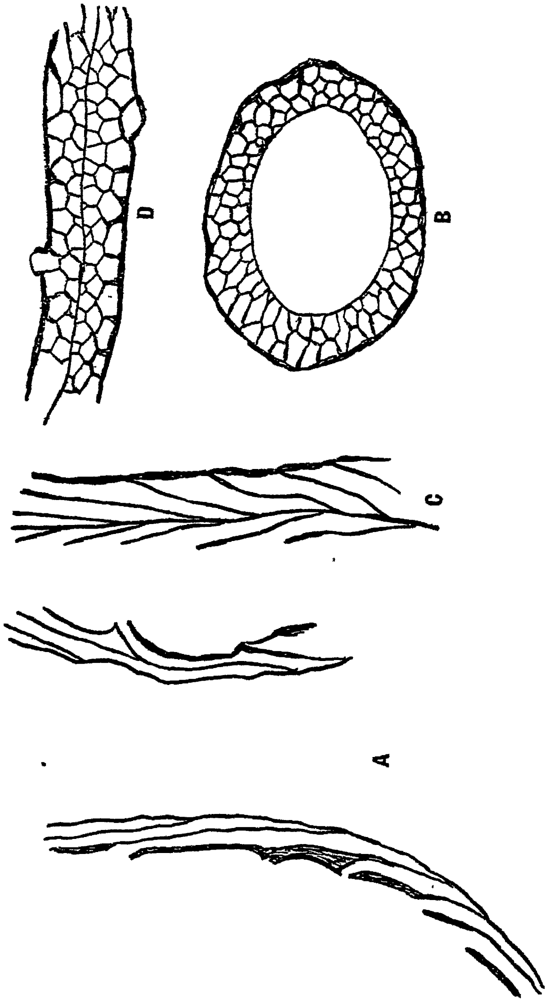


Fig. 18.—Genus *Trigonoecia* Canu and Bassler, 1922. A, B. *Trigonoecia tubulosa* D'Orbigny, 1851. A. Longitudinal section, × 16, of the hollow zoarium, showing cylindrical tubes with dorsal gemmation. B. Transverse section of a branch, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. C, D. *Trigonoecia neocomiensis* D'Orbigny, 1853. Portion of a longitudinal section, × 16, showing the triparietal gemmation and the club-shaped tubes. D. Transverse section, × 16, exhibiting the polygonal form of the tubes. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

In longitudinal section the tubes are cylindrical, long, with triparietal gemmation on the basal lamella and narrowed at their base

In transverse section the tubes are polygonal, with thin walls adjacent. The tubes adjacent to the lamella are small, because they correspond to the inferior part of the tubes.

*Occurrence.*—Lower Cretaceous: Sainte-Croix (Vaud), Switzerland; Hauterivian, Censeau (Doubs), France (Valangian), Fontenay and Auxerre (Yonne), France (Rhodonian).

*Plesiotypes.*—Cat. No. 69884, U.S.N.M.

### TRIGONOECIA HAIMEANA De Loriol, 1863

Plate 1, figs. 6–12

1863. *Reptomultisparsa haimeana* DE LORIOL, Les Invertébrés du Neocomien inférieur du Mont Salève près Genève, vol. 2, p. 136, pl. 17, fig. 4.

1883. *Reptomultisparsa haimeana* KEEPING, Fossils of the Neocomian of Upware and Brickhill (Cambridgeshire and Bedfordshire), p. 137.

1899. *Reptomultisparsa haimei* GREGORY, Catalogue of Cretaceous Bryozoa in the British Museum, vol. 1, p. 117, fig. 5.

*Measurements.*—

|  | Ste.-Croix | Faringdon | Gregory | Type |
|---|---|---|---|---|
|  | *Mm.* | *Mm.* | *Mm.* | *Mm* |
| Diameter of aperture | 0.10 | 0.10 | 0.10 | 0.10 |
| Diameter of peristome | .16 | .16 | ---------- | ---------- |
| Diameter of tubes | .20 | .20 | 20–.25 | .18–.22 |
| Distance of peristomes | .72–.80 | .64 | .60–1.00 | ---------- |
| Separation of peristomes | .72 | .48–.60 | ---------- | ---------- |

*Affinities.*—De Loriol's type is not very well preserved, but our specimens, which we have compared with it, are much better.

The zoarium incrusts sponges and shells over considerable surfaces (fig. 6). The large transverse overlapping wrinkles characteristic of the species have been observed in specimens from Sainte-Croix (fig. 7), as well as Faringdon (fig. 10). The ovicell is triangular, very convex, and quite similar to that in other species of the genus. Its dimensions are quite variable, varying from once to twice the size. The ovicell shown in Figure 12 is the largest one observed.

*Occurrence.*—Lower Cretaceous: Varappe, near Geneva, Switzerland (De Loriol) (Hauterivian), Sainte-Croix (Vaud), Switzerland (Valangian); Faringdon and Upware, England (Aptian).

*Plesiotypes.*—Cat. Nos. 69885, 69886, U.S.N.M.

### TRIGONOECIA (MESENTERIPORA) NEOCOMIENSIS D'Orbigny, 1853

Plate 2, fig. 11

1853. *Mesenteripora neocomiensis* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 808, pl. 756, figs. 7–9.

*Measurements.*—Diameter of orifice, 0.14–0.16 mm.; diameter of peristome, 0.18–0.20 mm.; distance of peristomes, 1.00–1.20 mm.; separation of peristomes, 0.70 mm.

*Structure.*—Although very beautiful, D'Orbigny's figure is not complete. A considerable number of tubes bear at their base large transverse wrinkles. They are not constant, it is true; when the tubes are very long and are inserted between two peristomes (distance of 1.20 mm.), the wrinkles are quite visible in the inferior nonsalient portion; when the tubes are short (distance, 0.70 mm.), the wrinkles have disappeared.

We have not observed the ovicell, but we classify the species provisionally in the genus *Trigonoecia* because the sections are identical with those of other species of the genus. The fronds being undulated, there is never perfect symmetry in the sections. Pergens and Gregory have erroneously identified this species with *Diastopora compressa* Goldfuss, 1827, in which the micrometric measurments are much smaller.

*Occurrence.*—Lower Cretaceous: Sainte-Croix, Switzerland (Valangian); Morteau (Jura), France (Urgonian).

*Plesiotype.*—Cat. No. 69887, U.S.N.M.

### Genus CARDIOECIA Canu and Bassler, 1922

The ovicell is triangular, transverse, *cordiform*, little convex, smooth, symmetrical; the oeciostome is small, salient, median. The tubes are club-shaped, with triparietal gemmation on a basal lamella.

*Genotype.*—*Cardioecia* (*Bidiastopora*) *neocomiensis* D'Orbigny, 1853. Lower Cretaceous (Neocomian, Aptian).

The ovicell is less salient and more expanded than in *Trigonoecia*. The tubes are longer and club-shaped. The latter character is clearly visible in transverse sections, which have a larger number of tubes and increase regularly from center to circumference. We have observed only the free forms of growth, but encrusting forms are quite possible. The oeciostome always measures 0.10 mm. and the oeciopore 0.06 mm. No exceptions to this have been found.

#### CARDIOECIA NEOCOMIENSIS D'Orbigny, 1853

Plate 2, figs. 1–7

1853. *Bidiastopora neocomiensis* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 800, pl. 784, figs. 9–11.

1902. *Bidiastopora campicheana* CANU, Bryozoaires fossiles, Collection Campich. Bull. Soc. Geol. France, ser. 4, vol. 2, p. 11.

*Measurements.*—Diameter of aperture, 0.10 mm.; diameter of peristome, 0.16 mm.; zooecial diameter, 0.20 mm.; distance of peristomes, 0.40–0.50 mm.; separation of peristomes, 0.50 mm.; width of large fronds, 3 mm.

*Variations.*—This species is very irregular and D'Orbigny's figure represents only one phase of it. In their perfect form the tubes are visible and salient (fig. 2). This character disappears easily even on the same fragment of frond (figs. 2, 7); the tubes cease to be visible and the peristomes are very salient (fig. 2). The latter frequently are less developed (figs. 3, 4, 6) and the superficial aspect is totally different. In some very rare cases they become almost adjacent (fig. 5.)

The ovicell shown in Figure 3 is the typical and perfect form; it is heart-shaped, transverse, convex, smooth, symmetrical, and its small oeciostome is placed in the median axis; but regularity and symmetry disappear rather easily (fig. 6). The oeciostome measures 0.10 mm. and the oeciopore 0.06 mm.

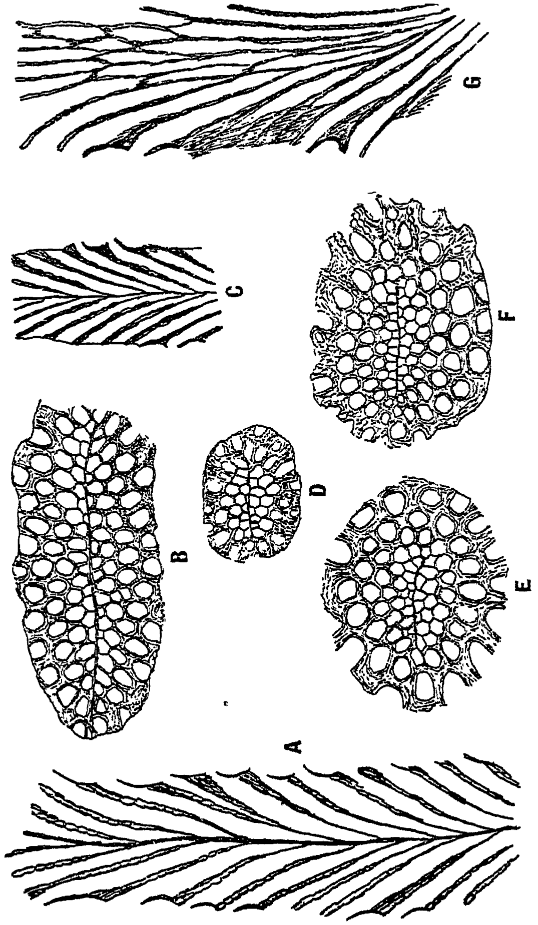


FIG. 19.—Genus *Cardioecia* Canu and Bassler, 1922. A, B. *Cardioecia neocomiensis* D'Orbigny, 1853. Longitudinal and transverse sections, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. C, D. *Cardioecia verticillata*, new species. Longitudinal and transverse sections, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. E, F, G. *Cardioecia faringdonensis*, new species. E, F. Two transverse sections, × 16, with the median lamella short and curved in the second. G. Portion of a meridian section, × 16, showing the form of the tubes. Lower Cretaceous (Aptian): Faringdon, England

The zone of growth is short but very thick (figs. 2, 5).

*Structure.*—In longitudinal section the tubes are long, club-shaped, much expanded at their extremity, where, in consequence of the closeness of the peristomes, they appear closed by pseudofacettes.

The gemmation is triparietal on a basal lamella (=median). The walls are thick and vesicular.

In transverse section the tubes are orbicular or elliptical, largest at the periphery, with very thick walls. The median (basal) lamella is almost rectilinear.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Plesiotypes.*—Cat. No. 69888, U.S.N.M.

### CARDIOECIA NEOCOMIENSIS PARVULA, new variety

Plate 2, fig. 8

The micrometric measurements are somewhat smaller and the ovicell less regular than in the typical form. The tubes are visible.

*Measurements.*—Diameter of orifice, 0.08 mm.; diameter of peristome, 0.14 mm.; distance of peristomes, 0.64 mm.; separation of peristomes, 0.50 mm.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Holotype.*—Cat. No. 69890, U.S.N.M.

### CARDIOECIA NEOCOMIENSIS ENTALOPHOROIDES, new variety

Plate 2, figs. 9, 10

The zoarium is cylindrical or somewhat compressed. The peristomes are arranged in verticells. The ovicell is more globular and less transverse.

*Measurements.*—Diameter of aperture, 0.12 mm.; diameter of peristome, 0.16 mm.; separation of peristomes, 0.56 mm.; distance of peristomes 0.34 mm.

The separation can be measured only in the portions of the surface where the peristomes are arranged in quincunx. The ovicell appears less cordiform and more globular because the zoarium is subcylindrical. This is not *Entalophora neocomiensis* D'Orbigny, 1853 in which the tubes are visable and more distant.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Cotype.*—Cat. No. 69889, U.S.N.M.

### CARDIOECIA VERTICELLATA, new species

Plate 3, figs. 1–4

*Description.*—The zoarium is cylindrical, arborescent. The tubes are very short, flat, indistinct or separated by a salient thread; the peristomes are thick, salient, orbicular, generally arranged in close *verticells.* The zone of growth is a broad cone. The ovicell is triangular, elongated, very convex, smooth; the oeciostome is small salient, orbicular.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of peristome, 0.14 mm.; distance of peristomes, 0.30 mm.; separation of peristomes, 0.40 mm.

*Variations.*—The tubes with prominent threads are visible only on the specimens with worn and little salient peristomes. The separation of the peristomes can be measured only on specimens where they are arranged in quinqunx.

The ovicell is somewhat different from that in other species and resembles *Trigonoecia.* It differs, nevertheless, in the absence of transverse wrinkles. Moreover, we know that the typical expanded form visible on the lamellar zoarium disappears easily on these cylindrical specimens.

*Structure.*—The sections are, indeed, those of the genus *Cardioecia.* In longitudinal section the tubes are club-shaped, with moniliform walls, but very thick and strongly calcified; the gemmation is triparietal on the median lamella.

In transverse section the tubes are orbicular or elliptical, with diameter increasing toward the periphery. The walls here are very thick.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Cotypes.*—Cat. No. 69891, U.S.N.M.

### CARDIOECIA HYSELYI De Loriol, 1869

Plate 3, figs. 5–8

1869. *Mesenteripora hyselyi* De Loriol and Gillieron, Monographie paleontologique de l'Urgonian de Landeron, Memoires Société helvetique des Sciences naturelles, vol. 23, p. 40, pl. 3, fig. 1.

*Measurements.*—Diameter of aperture, 0.12 mm.; diameter of peristome, 0.26 mm.; diameter of tubes, 0.24 mm.; distance of peristomes, 0.40–0.70 mm.; separation of peristomes, 0.52–0.60 mm.

*Affinities.*—We have not examined De Loriol's figured type and we are not very certain of our determination. De Loriol's descriptions and figures were always incomplete and inexact.

The tubes are visible or invisible; the peristomes are little or very salient, sometimes arranged in verticells. The ovicell is cordiform, rather regular, little convex. The zone of growth is thick.

The sections are identical with those of *Cardioecia neocomiensis* D'Orbigny, 1853, but the present species, which has a similar exterior aspect, differs in its larger peristomes and in its foliated and much broader fronds.

*Occurrence.*—Lower Cretaceous: Sainte-Croix (Vaud), Switzerland; (Valangian), Landeron (Neuchatel), Switzerland (Urgonian).

*Plesiotypes.*—Cat. No. 69892, U.S.N.M.

### CARDIOECIA FARINGDONENSIS, new species

Plate 3, figs. 9–15

*Description.*—The zoarium is free, cylindrical or compressed, with bifurcated fronds. The tubes are short, visible, convex, separated by a little developed furrow; the peristomes are obicular, salient, thick, arranged in quincunx or in close verticells. The zone of growth is broad or conical. The ovicell is cordiform, little salient, smooth; the oeciostome is salient, small, orbicular. The base is a little expanded.

*Measurements.*—Diameter of orifice, 0.14 mm.; diameter of peristomes, 0.28 mm.; distance of peristomes, 0.48–0.60 mm.; separation of peristomes, 0.80 mm.

*Structure.*—In longitudinal section the tubes are long, club-shaped, with moniliform walls, much expanded in their terminal portion; they appear closed by pseudofacettes on account of the closeness of the peristomes. The gemmation is triparietal on a median lamella.

In transverse section the tubes are round, increasing in size toward the periphery, separated by the vesicular tissue of the thickened walls. The median lamella is not always rectilinear.

In meridian sections the tubes are lozenge-shaped in the axis of the median lamella, which does not entirely traverse the zoarium; the lateral tubes have the normal form.

*Affinities.*—This beautiful species has the exterior aspect of *Cardioecia neocomiensis* D'Orbigny, 1853, but it differs in its larger micrometric dimensions in its fronds being much less expanded and more frequently cylindrical.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Cotypes.*—Cat. No. 69893, U.S.N.M.

### CARDIOECIA PAUPER, new species

Plate 5, figs. 1, 2

*Description.*—The zoarium is free, cylindrical. The tubes are indistinct, scarcely convex, smooth. The peristomes are arranged in transverse rows or in quincunx; they are orbicular, thin, little salient. The zone of growth is an elevated cone. The ovicell is small, elliptical, transverse, little convex, smooth.

*Measurements.*—Diameter of aperture, 0.14 mm.; diameter of peristome, 0.18 mm.; distance of peristomes, 0.48–0.56 mm.; separation of peristomes, 0.64 mm.; diameter of zoarium, 3 mm.

*Affinities.*—We figure the two sides of the same specimen in order to show that the peristomes are arranged in transverse rows on one side and in quincunx on the other. This irregularity provokes an equivalent irregularity in the sections. Those that we have made show the same characters as in the preceding species, thus leaving no doubt as to the generic placing.

The species differs from *Cardioecia faringdonensis* in its smaller, more crowded and less salient peristomes.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Holotype.*—Cat. No. 69898, U.S.N.M.

### Genus NEMATIFERA Canu and Bassler, 1922

The ovicell is an elongated sack, subsymmetrical, irregular, scarcely convex; the oeciostome is terminal, very small, hardly salient. All of the tubes are bordered with salient threads exteriorily. The tubes are short, cylindrical, polygonal; the gemmation is triparietal on a basal lamella.

*Genotype.*—*Nematifera* (*Elea*) *reticulata* D'Orbigny, 1853. Lower Cretaceous (Neocomian, Urgonian). The ovicells so far discovered are little distinct but clearly different from those of *Trigonoecia*, although the structure in sections in these two genera is very similar. The tubes are bordered exteriorly by a salient thread, which never occurs in *Trigonoecia*. According to the exterior resemblances, this genus ought to have Jurassic representatives.

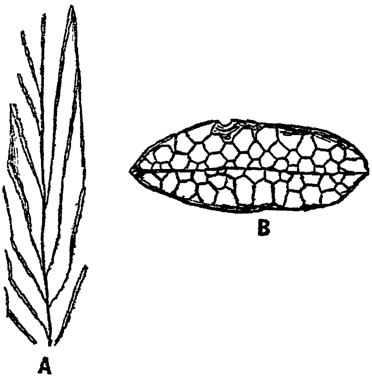


FIG. 20.—*Nematifera reticulata* D'Orbigny, 1853. Longitudinal and transverse sections, × 16. Lower Cretaceous (Valangian): Sainte Croix, Switzerland

#### NEMATIFERA RETICULATA D'Orbigny, 1853

Plate 4, figs. 1–4

1853. *Elea reticulata* D'ORBIGNY, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 629, pl. 782, figs. 9–12.

*Measurements.*—Diameter of orifice, 0.14 mm.; diameter of peristomes, 0.24 mm.; distance of peristomes, 0.60 mm.; separation of peristomes, 0.64 mm.

*Affinities.*—This species is not at all a member of the Eleidae. The peristome is orbicular, but, through weathering, it becomes semielliptical. There are no facettes, but these are the walls of the tubes themselves that are very short because of the close approach of the peristomes. The tubes are almost always bordered with a salient thread, a phenomenon produced in many other species with tubes much longer. Finally, there is never an operculum, and the ovicell is very different from that in the Eleidae. The separating threads outline the peristome entirely, a characteristic which deceived D'Orbigny.

*Structure.*—In longitudinal section the tubes are short, cylindrical, somewhat expanded nevertheless in the vicinity of the pseudofacettes; gemmation is triparietal on a basal lamella.

The transverse section does not show a large number of tubes; they are polygonal, with thin and adjacent walls; the smallest are in the vicinity of the median lamella.

*Occurrence.*—Lower Cretaceous: Sainte-Croix (Vaud), Switzerland (Valangian); Morteau (Doubs), France (D'Orbigny) (Neocomian).

*Plesiotypes.*—Cat. No. 69894, U.S.N.M.

### NEMATIFERA ACUTA D'Orbigny, 1853

Plate 4, fig. 12

1853. *Bidiastopora acuta* D'Orbigny, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 799, pl. 784, figs. 3–5.

*Measurements.*—Diameter of orifice, 0.08–0.10 mm.; diameter of peristome, 0.12 mm.; diameter of zooecium, 0.20 mm.

This species is well characterized by its very thin and sharp zoarial margins. The separating threads turn around the peristome, which is thin; the pseudofacettes are flat.

We have not had the chance to discover the ovicell, and we have classified the species according to its exterior analogies and the transverse section which is always easily observed.

According to Pergens, 1889, *Bidiastopora campicheana* D'Orbigny, 1853, is a synonym, but we do not believe this is true; moreover D'Orbigny's figure indicates an altered specimen.

Marsson, 1887, believed he had found this species in the Campanian of Rügen. We have not rediscovered it ourselves.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69895, U.S.N.M.

### NEMATIFERA INCRUSTANS, new species

Plate 4, figs. 5–7

*Description.*—The zoarium encrusts shells, with many irregularly arranged lamellae; it emits free, thick expansions irregular around a median lamella. The tubes are distinct, separated by a salient thread, flat, short (pseudofacettes). The peristomes are orbicular, salient, arranged in quincunx. The zone of growth is rather broad and formed of three or four series of tubes. The ovicell is suborbicular, little convex, smooth.

*Measurements.*—Diameter of orifice, 0.12 mm.; diameter of tubes, 0.22 mm.; distance of peristomes, 0.64 mm.; separation of peristomes, 0.52–0.60 mm.

*Affinities.*—The superb figured specimen measures 5 centimeters in length. Some free broken expansions show the median lamella and consequently the identity with the other species of the genus.

This species differs from *Trigonoecia haimeana* De Loriol, 1868, which exhibits also large multilamellar specimens, in the presence of salient threads, in the absence of overlapping wrinkles, and in the very different form of its ovicell.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

*Holotype.*—Canu collection.

### NEMATIFERA RETICULOIDES, new species

Plate 4, figs. 8–11

*Description.*—The zoarium is free, cylindrical, bifurcated, or reticulate. The tubes are distinct, flat, separated by a salient thread, forming pseudofacettes when they are short. The peristomes are orbicular, salient, thick, arranged in *Peripora*, that is to say, in groups of closely arranged transverse rows. The zone of growth is a cone, little elevated.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of zooecium, 0.20–0.24 mm.; distance of peristomes, 0.40–0.64–0.80 mm.; separation of peristomes, 0.64 mm.

*Affinities.*—The peristomes are rarely arranged in quincunx and their distance is about 0.64 mm. They are somewhat salient and adjacent when they are arranged in transverse lines; with weathering they are no longer orbicular and their form is close to that of the peristomes in the Eleidae, but they never have opercula. The distance between the groups of transverse lines is from 0.80 to 1.00 mm.

This species differs from *Nematifera reticulata* D'Orbigny, 1853, in its smaller micrometric dimensions, in the arrangement of the peristomes in the *Peripora* form, and in the cylindrical zoarium. It differs from *Nematifera acuta* D'Orbigny, 1853, in the oral dimensions and in the cylindrical and not lamellar zoarium. The transverse section shows that the zoarium is sometimes a little compressed.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69896, U.S.N.M.

### Genus MESENTERIPORA Blainville, 1834

#### MESENTERIPORA MARGINATA D'Orbigny, 1853

Plate 6, fig. 3

1899. *Diastopora marginata* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 137. (Bibliography and occurrence.)

*Measurements.*—Diameter of aperture, 0.14–0.16 mm.; diameter of peristome, 0.22 mm.; diameter of tubes, 0.27 mm.; distance of peristomes, 2 mm.; separation of peristomes, 0.64–0.72 mm.

*Structure.*—We provisionally place this beautiful species next to *Nematifera* because of the presence of separating salient threads, but we have not yet been able to discover the ovicell. Moreover, the transverse section is of a type entirely special. There is no basal lamella, and although the lamellar zoarium has two sides they are not formed by two lamellae placed back to back. The tubes are polygonal, with thin walls arranged in quincunx and confused.

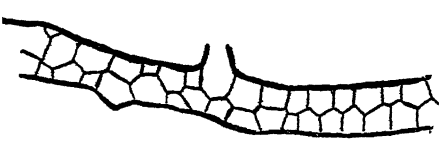


FIG. 21.—*Mesenteripora marginata* D'Orbigny, 1853. Transverse section, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland, and Villers-le-lac (Jura), France.

*Plesiotypes.*—Cat. No. 69897, U.S.N.M.

## Family PLAGIOECIIDAE Canu, 1918

### Genus NOTOPLAGIOECIA Canu and Bassler, 1922

The ovicell is an irregular convex capsule, replacing many peristomes. The tubes are short, club-shaped, with moniliform walls thickened at the extremities. The gemmation is dorsal. There is no basal lamella.

*Provisional genotype.*—*Notoplagioecia faringdonensis* Canu and Bassler, 1922.

*Range.*—Cretaceous (Aptian, Coniacian).

#### NOTOPLAGIOECIA FARINGDONENSIS Canu and Bassler, 1922

Plate 5, figs. 3–5

*Description.*—The zoarium is free, cylindrical or compressed. The tubes are indistinct, very little convex, smooth. The peristomes are orbicular, thin, arranged in quincunx or in transverse rows. The zone of growth is an elevated cone. The ovicell is an irregular sack covering many adjacent tubes.

*Measurements.*—Diameter of aperture, 0.16 mm.; diameter of peristome, 0.20 mm.; distance of peristomes, 0.48–0.56 mm.; separation of peristomes, 0.72 mm.; diameter of branches, 3 mm.

*Structure.*—In longitudinal sections the tubes are short, club-shaped, much expanded at their terminal parts, sometimes showing pseudofacettes. The gemmation is dorsal, although triparietal in appearance because of the little length of the tubes. The walls are moniliform, much widened at their extremity.

In transverse sections the tubes are rounded, much smaller at the center than at the circumference, with vesicular walls much thickened, especially at the periphery.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Cotypes.*—Cat. No. 68718, U.S.N.M.

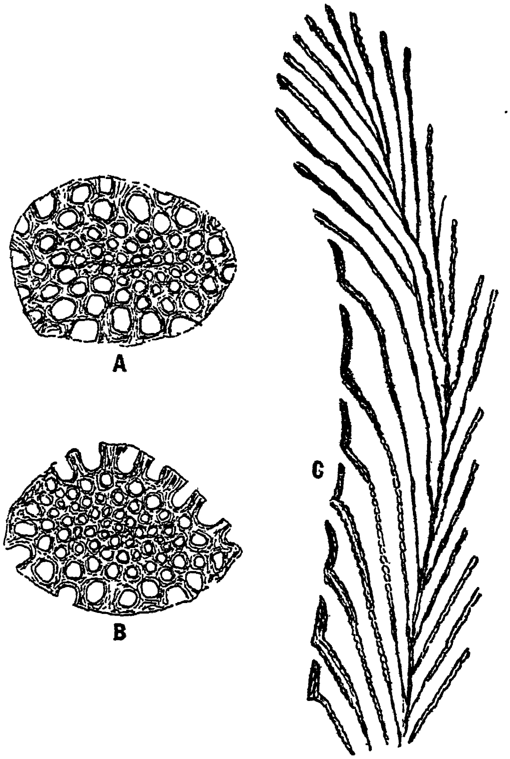


FIG. 22.—*Notoplagioecia faringdonensis* Canu and Bassler, 1922. A, B. Two transverse sections, × 16. C. Longitudinal section, × 16, showing the club-shaped tubes, the pseudofacettes, and the vesicular walls. Lower Cretaceous (Aptian): Faringdon, England

### Genus CEA D'Orbigny, 1852

#### CEA GRANULATA, new species

Plate 5, figs. 6–14

*Description.*—The zoarium is free, formed of narrow, compressed bifurcated fronds. The tubes are rarely visible. The orifices without facette are large, polygonal, irregular, elongated or transverse. The facettes are indistinct, flat, *granular*. The peristomes are orbicular, thin, salient, arranged in quincunx. The zone of growth is large, becoming thinner on the median lamella.

*Measurements.*—Diameter of aperture, 0.10 mm.; diameter of peristomes, 0.14 mm.; distance of peristomes, 0.40 mm.; separation of peristomes, 0.40 mm.; diameter of orifice without facettes, 0.20–0.24 mm.; diameter of zoarium, 3 mm.

*Structure.*—The most frequent aspect is that of Figure 9; the orifices are large and more or less transverse. The latter are sometimes elongated (fig. 11). The tubes are occasionally visible below the orifices, but they remain indistinct. As in all the Ceidae, the facettes are rarely preserved (fig. 13); they are perforated by an orbicular aperture.

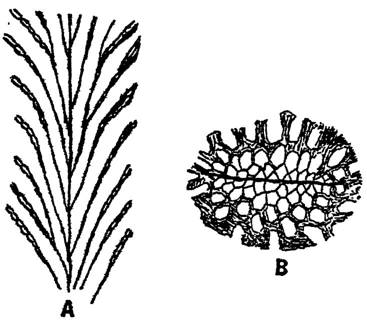


FIG. 23.—*Cea granulata*, new species. A, B. Longitudinal and transverse sections, × 16. Lower Cretaceous (Aptian): Faringdon, England

In longitudinal section the tubes are club-shaped with walls thickened at their extremity; the gemmation is triparietal on a basal lamella.

In transverse section the tubes are polygonal, with thin walls in the vicinity of the basal lamella. They have a center, rounded toward the periphery by an internal secretion because the polygonal walls are always visible.

The ovicell is not known.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Cotypes.*—Cat. No. 69899, U.S.N.M.

## Family DIAPEROECIIDAE Canu, 1918

### Genus DIAPEROECIA Canu, 1918

### DIAPEROECIA (?) SIMPLEX, new species

Plate 4, fig. 16

*Description.*— The zoarium is unilamellar; the noncellular face is transversely striated. The tubes are quite salient, arranged in quincunx; the orifices are orbicular; the peristomes are thick. The ovicell is a limited sack, very convex, perforated by a normal tube; the oeciostome is small, salient, placed at the middle of the ovicell.

*Measurements.*—Diameter of aperture, 0.12 mm.; diameter of peristome, 0.18 mm.; diameter of oeciostome, 0.10 mm.

*Affinities.*—This species is not a typical *Diaperoecia*, but we have classified it in this genus because of the median oeciostome. It appears intermediate between *Diaperoecia* and *Tubulipora*, but more specimens are necessary before the species can be classified without doubt.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69900, U.S.N.M.

### DIAPEROECIA ORBIFERA, new species

Plate 8, fig. 17

*Description.*—The zoarium is subcircular; it incrusts shells. The tubes are very short, little distinct, finely granulated, and frequently longitudinally striated; the apertures are elliptical; the peristomes are thin, very close together. The ovicell is large, *orbicular*, very convex, traversed by the subjacent tubes.

*Measurements.*—Diameter of aperture, 0.06 mm.; diameter of peristome, 0.10 mm.; distance of peristomes, 0.40 mm.; separation of peristomes, 0.40–0.48 mm.

*Affinities.*—This species is very close to *Berenicea papillosa* Reuss in the closeness of its peristomes. It differs from it in its ovicells, which are orbicular and not elliptical and very elongated.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69901, U.S.N.M.

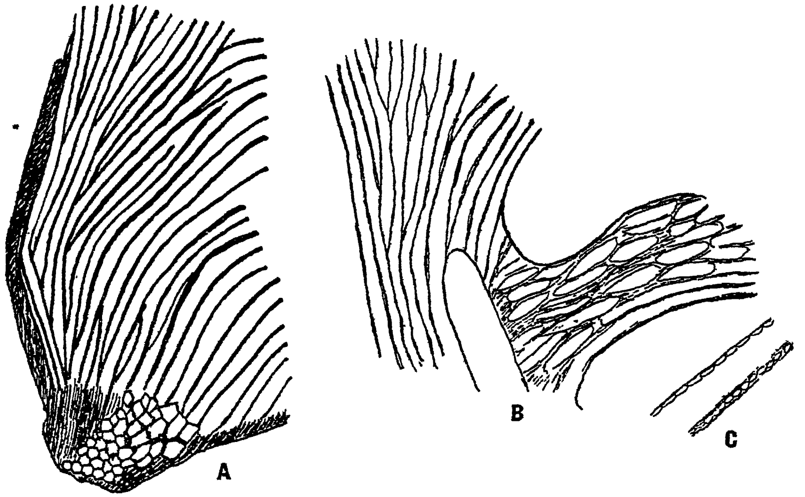


FIG. 24.—*Fasciculipora flabellata* D'Orbigny, 1853. A. Longitudinal thin section, × 16. B. Meridian thin section. × 16, in the vicinity of a bifurcation. C. Zooecial walls, × 35, showing the arrangement of vesicles. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

## Family FRONDIPORIDAE Busk, 1875

### Genus FASCICULIPORA D'Orbigny, 1846

### FASCICULIPORA FLABELLATA D'Orbigny, 1853

Plate 7, figs. 1, 2

1853. *Fasciculipora flabellata* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 669, pl. 783, figs. 8–11.

D'Orbigny has figured only isolated fascicles, but in reality the zoarium is bushy. The fascicles are strongly and largely attached by their base; they are very irregular in form and size. The tubes open at the extremity of the fascicles and often laterally.

The base of the small zoarium is pointed, but in the large zoaria it is somewhat wider; they are flabelliform, and it is difficult to understand how they were able to maintain equilibrium on their support.

In longitudinal section the tubes are long, cylindrical, with intrazoarial gemmation; the walls are vesicular but with very small elements. The zoarial walls are thickened.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69902, U.S.N.M.

## Family CYTISIDAE D'Orbigny, 1854

### Genus CYRTOPORA Hagenow, 1851

### CYRTOPORA CAMPICHEANA D'Orbigny, 1853

1853. *Cyrtopora campicheana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 673, pl. 761, figs. 14, 15.

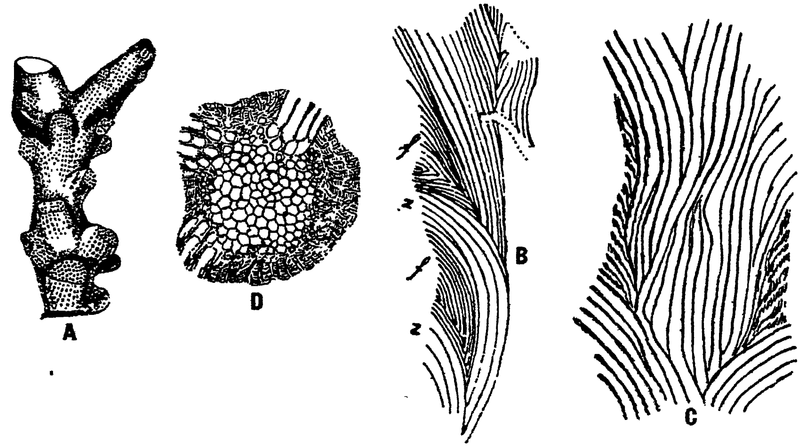


FIG. 25.—Genus *Plethopora* Hagenow, 1851. A, B. *Plethopora malmi* Hennig, 1894. A. Zoarium, × 2.6. B. Longitudinal section magnified, showing zooecial tubes (*z*) and the nematopores (*f*) (A, B, after Hennig, 1894). Upper Cretaceous of Sweden. C, D. *Plethopora aptensis*, new species. C. Longitudinal section, × 16, showing the nematopores with thickened walls and the large axial tubes. D. Transverse section, × 16, exhibiting the base of the saliant fascicles with open tubes and the thin zone of nematopores. Lower Cretaceous (Aptian): Faringdon, England

Our transverse section confirms that of Gregory, 1909. The tubes are very large, polygonal, with thin adjacent walls.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69950, U.S.N.M.

### Genus PLETHOPORA Hagenow, 1851

1851. *Plethopora* HAGENOW, Die Bryozoen der Maastrichter Kreidebildung, p. 45.

The tubes are cylindrical; they are grouped in salient, orbicular bundles opening in all directions. The nematopores are arranged entirely around the zoarium.

*Genotype.*—*Plethopora verrucosa* Hagenow, 1851. Cretaceous (Aptian, Maastrichtian).

The place of the nematopores is variable in the Cytisidae, according to the nature of the genera. In *Plethopora* they are arranged entirely around the zoarium, while in other genera they are found only on the dorsal.

### PLETHOPORA APTENSIS, new species

Plate 7, figs. 3, 4

*Description.*—The zoarium is free, cylindrical, bifurcated. The zooecia are grouped in fascicles, which are salient and orbicular. The nematopores are small, polygonal, arranged entirely around the zoarium.

*Measurements.*—Diameter of fascicles, 0.56 mm.; diameter of branches, 2 mm.

*Structure.*—In longitudinal section the tubes are cylindrical, long, with peripheral gemmation; they occupy the essential and principal part of the zoarium. The nematopores appear solely on the zoarial margin in small spaces between the fascicles, thus confirming the thin section of Hennig.

In transverse sections the larger tubes are in the middle. These, in branching, engender the axial tubes of the fascicles. On the borders the small pores are those of the peripheral nematopores.

*Affinities.*—The distinction between the species of this genus is rather difficult to make from the published figures. Comparisons of specimens, on the contrary, permit a differentiation, according to the relative size of the orifices, of the nematopores, and the form of the fascicles. The circular form of the latter and the large size of the zoarium well characterize this species.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69903, U.S.N.M.

### Genus PLETHOPORELLA Canu and Bassler, 1922

The ovicell is elliptical, elongated, large, little convex, smooth. The tubes are cylindrical, without peristome, with orbicular orifice; their walls are moniliform; they are recurved at their extremity. The gemmation is peripheral around a bundle of axial tubes. No adventitous tubes.

*Genotype.*—*Plethoporella* (*Plethopora*) *ramulosa* D'Orbigny, 1847.

*Range.*—Cretaceous (Campanian, Maastrichtian).

*History.*—D'Orbigny was in error in comparing the genotype with *Plethopora verrucosa* Hagenow, 1851. The internal structure is very different, for not only are there no nematopores but the tuberosities which ornament the zoarial surface are not formed of bundles of tubes.

### PLETHOPORELLA RAMULOSA D'Orbigny, 1847

1847. *Monticulipora ramulosa* D'ORBIGNY, Prodrome de Paléontologie Stratigraphique, p. 279, no. 1345.

1854. *Plethopora ramulosa* D'ORBIGNY, Paléontologie françaisc, Terrain Crétacé, p. 1045, pl. 799, figs. 1–3.

*Structure.*—D'Orbigny was deceived by the tuberosities which ornament the zoarial surface and classed this species in *Plethopora* incorrectly. The section which he illustrated, however, indicates not a single bunch of tubes. We have prepared several excellent longitudinal sections, one of which made from a normal zoarium showed on one side two subcolonies, while on the other side the tubes continued to grow regularly. The enveloping lamella partially surrounded the primitive colony and had its origin in a normal tube. All the species with peripheral gemmation pass easily from the free form to the incrusting form and conversely. Another longitudinal section shows that the tubes of the tuberosities are simply somewhat wider than the tubes of the intermediate spaces. The moniliform structure and the gemmation are identical in the two cases. The walls are formed of large vesicles.

In transverse sections the central tubes are equal in size and polygonal. The smaller ones, which appear sporadically, are indicative of the peripheral gemmation. The lozenge-shaped ones of the periphery represent the superior and recurved part of the tubes.

In tangential sections the tubes are subcircular and buried in a thick vesicular coenenchyma. They are smaller in the intertuberose zones, in conformity with the longitudinal section. The small tubes which appear sporadically are young tubes; they reveal the peripheral gemmation.

This structure is exactly that of ramose *Ceriopora*, and it is in this genus that we would have classed this species had we not had the chance to discover the ovicell. The latter is analogous to that of other Cytisidae and is simply more elliptical.

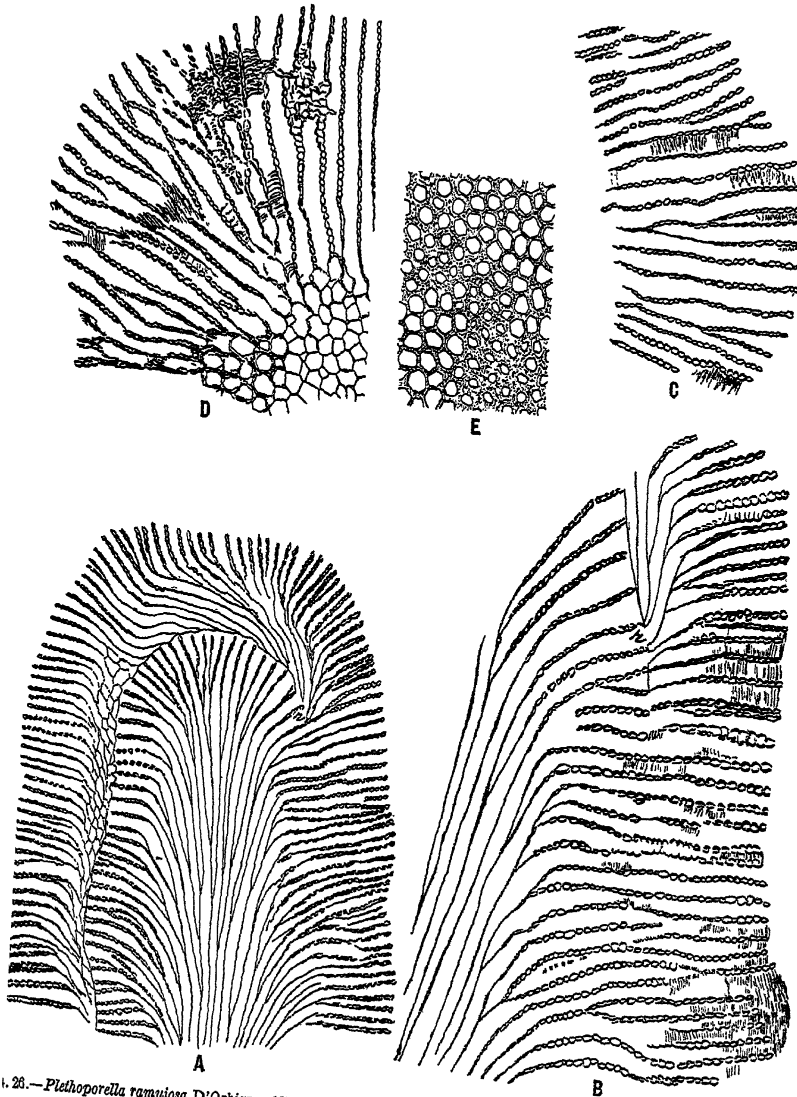
*Occurrence.*—Cretaceous (Campanian): Montmoreau, Brossac, Draullard, St. Aulais, Echebrune and Daviat (Charente), France. Cretaceous (Maastrichtian): Royan (Charente inferieure), Manie Roux and St. Lheurine (Dordogne), France.

*Plesiotypes.*—Canu collection and Cat. No. 68980, U.S.N.M.

### Genus CHARTECYTIS, new genus

Greek: Chartes, sheet, in allusion to the form of the branches.

The ovicell is elliptical, transverse, placed in the vicinity of the bifurcations. The tubes are cylindrical, with greatly thickened walls, with regular peripheral gemmation. The orifice is lozenge-shaped, much elongated, without peristome.



26.—*Plethoporella ramuiosa* D'Orbigny, 1853. A. Longitudinal section, × 8, in a zoarium containing a partially envelop-ng subcolony, the initial tube of which is at *r*. B. Portion of fig. A, × 16. C. Part of longitudinal section, × 16, through tuberosity where the tubes are broader. D. Portion of a transverse section × 16. E. Tangential section, × 16, show-ng the larger tubes of the tuberosities and the other smaller tubes. Upper Cretaceous (Maastrichtian): Royan, France

*Genotype.*—*Chartecytis compressa*, new species, Neocomian.

In the family Cytisidae zoarial forms with compressed fronds have not yet been noted. This form is the result of very regular peripheral gemmation; moreover, the extremity of the branches have the aspect of *Heteropora*.

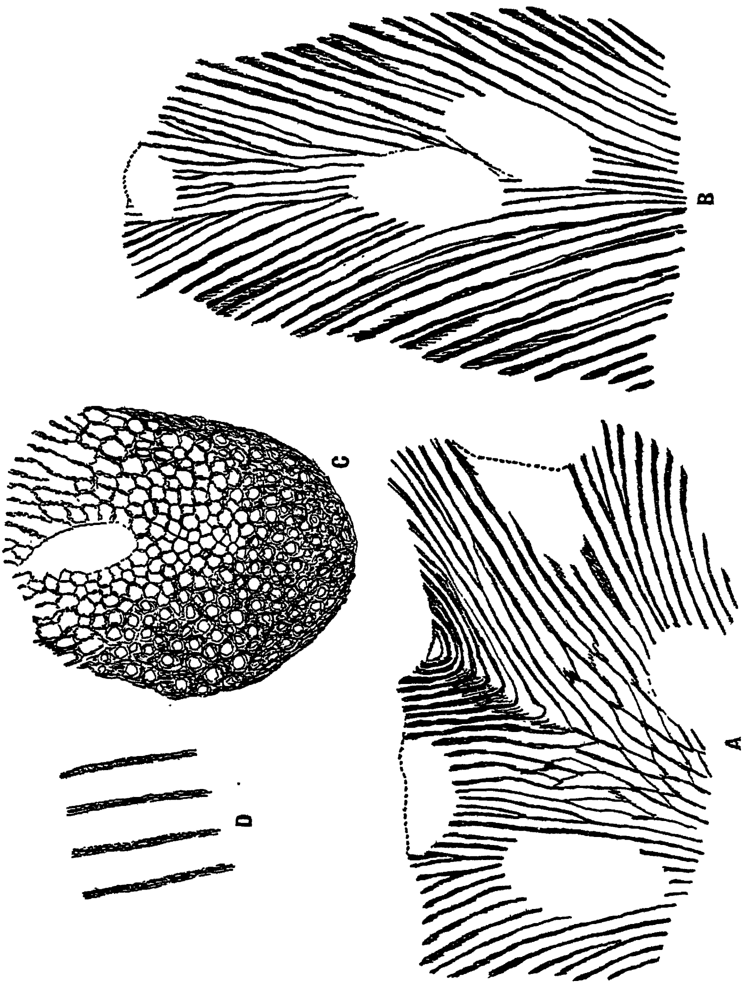


FIG. 27.—*Chartecytis compressa*, new species. A. meridian section, × 16, showing the special method of ramification of the branches. B. Longitudinal section, × 16, illustrating the peripheral gemmation. C. Transversal thin section, × 16. D. Zooecial walls, × 45, showing the minute central vesicles. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

**CHARTECYTIS COMPRESSA**, new species

Plate 7, figs. 8–12

*Description.*—The zoarium is free, branching, with compressed fronds. The orifices are elongated slitlike areas, lozenge-shaped, irregular, arranged in quincunx, without peristome. The ovicell is orbicular or elliptical, elongate or transverse, smooth, very salient, limited, and placed on the dorsal of the inferior tubes.

*Measurements.*—Diameter of orifice, 0.08 mm.; diameter of branches, 2.5 mm.; length of orifice, 016–0.20 mm.

*Structure.*—In transverse section the tubes are cylindrical, with greatly thickened walls; the central tube is perhaps a little larger. In longitudinal section the tubes are very long, with peripheral gemmation, very regular, with thickened walls.

This structure is quite simple. In general these forms of the tubes are oriented on one zoarial side; here the colony has two cellular sides, a rare occurrence.

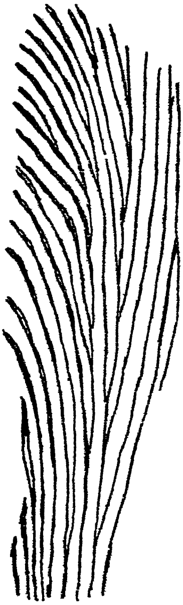


FIG. 28.—*Retenoa campicheana* D'Orbigny, 1853. Longitudinal section, × 16, showing the cylindrical tubes and the intrazoarial gemmation. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Occurrence.*—Lower Cretaceous. Valangian at Sainte-Croix, Switzerland; Hauterivian at Censeau (Doubs); Neocomian at St. Claude and Cinquetral (Doubs), France.

*Cotypes.*—Cat. No. 69904, U.S.N.M.

### Genus RETENOA Gregory, 1909

1909. *Retenoa* GREGORY, Catalogue of Cretaceous Bryozoa in the British Museum, vol. 2, p. 28.

Cytisidae, with an erect frondose zoarium, composed of a network of dichotomous, anastomosing branches. The apertures all open on one face of the zoarium. The tubes are cylindrical, with lozenge-shaped orifices, with intrazoarial gemmation.

*Genotype.*—*Retenoa* (*Frondipora*) *campicheana* D'Orbigny, 1853.

This genus is little different from *Homoeosolen* Lonsdale, 1850. It differs exteriorily in the absence of pinnules, and especially in its reticulate zoarium, which is a character of little importance. However, the gemmation is intrazoarial and not dorsal, which is a genuine difference. Gregory erroneously in 1909 classified this genus in the family Theonoidae; it is one of the typical Cytisidae on account of the nature of its ovicell.

### RETENOA CAMPICHEANA D'Orbigny, 1853

Plate 7, figs. 5–7

1853. *Frondipora campicheana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 678, pl. 783, figs. 12–16.

1909. *Retenoa campicheana* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 28. (Geologic distribution.)

*Structure.*—We have had the good fortune to discover numerous ovicelled specimens. The ovicell is an elliptical capsule, limited, convex, smooth, placed laterally on the dorsal, usually beneath the bifurcations.

In transverse section the tubes are equally rounded, with thick walls. In longitudinal sections they are cylindrical, with peripheral gemmation oriented around an imaginary axis. The dorsal tubes are closed (intrazoarial gemmation). The zooecial walls are vesicular, with very small elements. This is very much like the section in *Frondipora,* but the ovicell is altogether different.

*Occurrence.*—Lower Cretaecous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotypes.*—Cat. No. 69905, U.S.N.M.

## Family THEONOIDAE Busk

The family Theonoidae, as defined by Gregory in 1899 and 1909, embraced the following genera:

*Actinopora* D'Orbigny, 1853, *Conotubigera* D'Orbigny, 1853 (*Serietubigera* D'Orbigny, 1853), *Multitubigera* D'Orbigny, 1853, *Theonoa* Lamouroux, 1821, and *Retenoa* Gregory, 1909, with *Multifascigera* D'Orbigny, 1853 (= *Meandrocavea*), *Lopholepis* Hagenow, 1851, and *Radiofascigera* D'Orbigny, 1853, probably belonging to the Osculiporidae. In its ovicell *Retenoa* is a typical member of the *Cytisidae. Radiofascigera* in its ovicell, classed with doubt in the Osculiporidae, ought to be maintained in the vicinity of *Actinopora* (multiserial) and of *Multitubigera.*

The known ovicells are close to those of the Cytisidae without being perfectly identical. The family of Theonoidae could be maintained therefore with some restrictions. Unfortunately, the ovicell of the type genus *Theonoa* is still unknown. On the other hand, the uniserial *Actinopora* of the *complanata* group (= *organisans*) have a different ovicell of the type of *Plagioecia.*

If the family should be maintained it ought to contain the following genera:

*Actinopora* (multiserial) D'Orbigny, 1853, *Radiofascigera* D'Orbigny, 1853, *Multitubigera* D'Orbigny, 1853, and probably according to zoarial resemblances *Multifascigera* D'Orbigny, 1853, *Lopholepis* Hagenow, 1851, *Theonoa* Lamouroux, 1821, and *Serietubigera* D'Orbigny, 1853.

Although established on simple zoarial appearances, all of these genera, after a study of the known sections, appear to have an evident reality, the mode of gemmation and the arrangement of the tubes serving as generic characters.

### Genus ACTINOPORA D'Orbigny, 1853

#### ACTINOPORA STELLATA Koch and Dunker, 1837

Plate 6, figs. 1, 2

1909. *Actinopora stellata* GREGORY, Catalogue of the Cretaceous Bryozoa, vol. 2, p. 21. (Bibliography.) (*Actinopora regularis* D'Orbigny, 1853.)

The young zoaria are berenicoid, like the one we have figured. Waters discovered the ovicell and has sent us a drawing, which we reproduce. The ovicell is an ovoid capsule with limited outlines, interrupting the fascicles. It belongs to the group of the Cytisidae, although somewhat smaller.

This species has been chosen as the type of the genus *Actinopora* D'Orbigny, 1853, by Gregory, 1909. The fascicles are multiserial. Canu, 1917, discovered the ovicell of *Actinopora complanata* Roemer, 1840 (=*organisans* D'Orbigny, 1851). It is of the type *Plagioecia*. The fascicles are uniserial.

Under these circumstances it is necessary, then, to maintain in the Cytisidae (or Theonoidae) the multiserial species (genus *Actinopora*) and in the Plagioeciidae the uniserial species (genus *Discotubigera*).

We still maintain the genus *Desmeplagoecia*, as it is not certain that all of the *Discotubigera* have the same ovicell.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix and Villers-le-Lac, Switzerland.

*Plesiotype.*—Cat. No. 69906, U.S.N.M.

### Genus MULTITUBIGERA D'Orbigny, 1853

1853. *Multitubigera* D'Orbigny, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 767.

Theonoidae with a compound zoarium composed of many confluent *Actinopora*.

*Genotype.*—*Multitubigera gregaria* D'Orbigny, 1850. Cretaceous.

### MULTITUBIGERA CAMPICHEANA D'Orbigny, 1853

Plate 6, figs. 4–8

1853. *Multitubigera campicheana* D'Orbigny, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 768, pl. 763, figs. 10–13.

The ovicell is a small ovoid capsule with definite outlines, interrupting an intermediate fascicle between two other complete ones. It is analogous to that of *Actinopora stellata* Koch and Dunker, 1837; it belongs to the group of the Cytisidae, although a little smaller. The zoaria of this genus are formed of confluent *Actinopora*.

The general form is quite variable. Very often the zoarium is flabelliform and formed of two incomplete subcolonies united by their dorsal. Again the zoarium remains flabelliform and formed of three disks of *Actinopora*. Finally, the zoarium may form an irregular mass measuring as much as 3 centimeters in diameter and containing as many as eight confluent subcolonies. In all these cases the base is an edge more or less thin which does not permit one to understand the mode of attachment and how the colony is able to retain its equilibrium. The tubes are cylindrical, with dorsal gemmation. The fascicles are bi- or triserial. The ovicell is always placed on an exterior flabelliform subcolony in the neighborhood of the margin of growth. The zoarial pentagons figured by D'Orbigny are exaggerated; in reality the central subcolonies are irregularly orbicular.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotypes.*—Cat. No. 69907, U.S.N.M.

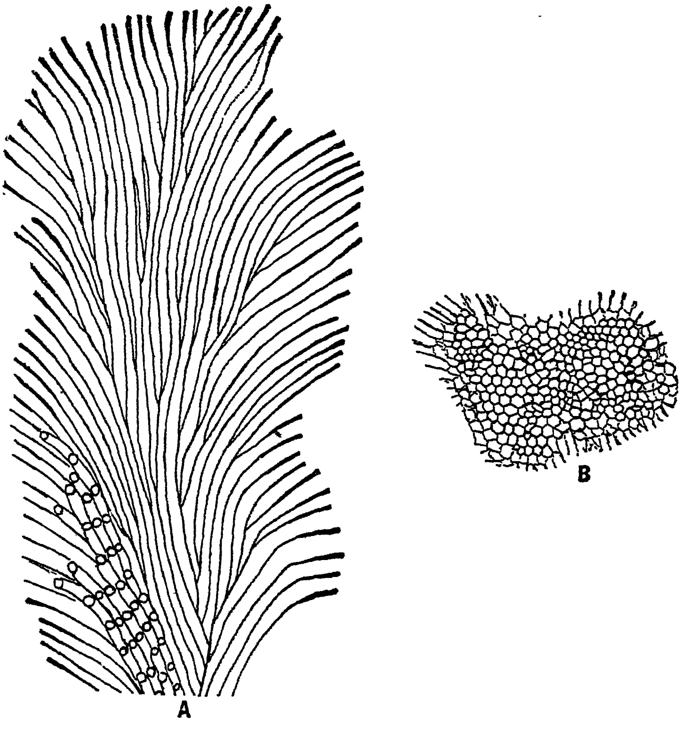


FIG. 29.—*Radiofascigera ramosa* D'Orbigny, 1853. A. Longitudinal section, × 16. The tubes are thickened at their extremity. B. Transverse section, × 16. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

### Genus **RADIOFASCIGERA** D'Orbigny, 1853

1853. *Radiofascigera* D'ORBIGNY, Paléontologie francaise, Terrain Crétacé, vol 5, p. 691.

Theonoidae of subcylindrical branches formed of numerous confluent colonies of *Actinopora.*

*Genotype.*—*Radiofascigera ramosa* D'Orbigny, 1853. Cretaceous.

### RADIOFASCIGERA RAMOSA D'Orbigny, 1853

Plate 6, fig. 10

1853. *Radiofascigera ramosa* D'ORBIGNY, Paléontologie francaise, Terrain Crétacé, vol. 5, p. 682, pl. 783, figs. 17–19.

The ovicell is a small capsule with limited outlines, absolutely analogous in form and position with that of *Actinopora* and *Multitubigera*. It belongs, therefore, in the group Cytisidae but the dimensions are smaller. The oeciostome, rarely visible, seems to be a very minute perforation more or less terminal.

According to D'Orbigny, the zoarium is formed of subcolonies of *Actinopora* grouped in cylindrical branches. In reality the colonies are more often claviform and never branched. The subcolonies are rarely orbicular, but are generally incomplete and flabelliform (*Pavotubigera*).

In transverse sections the tubes are polygonal, with adjacent walls. In longitudinal sections the tubes are cylindrical, with dorsal gemmation. It is difficult to decipher the subcolonies exteriorily visible.

D'Orbigny's figures are clearly diagrammatic. The zoaria are very irregular and become almost massive when they become greatly enlarged at their extremity. The multiserial fascicles are a great deal shorter than in *Actinopora stellata* Koch and Dunker, 1847, and *Multitubigera campicheana* D'Orbigny, 1853. For these various reasons we believe that the genus *Radiofascigera* D'Orbigny, 1853, can be maintained at least provisionally.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotypes.*—Cat. No. 69908, U.S.N.M.

### Genus MULTIFASCIGERA D'Orbigny, 1853

1853. *Multifascigera* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 687.

Theonoidae composed of superposed lamellae, each formed of subcolonies in the *Actinopora* and *Lopholepis* growth stages.

*Genotype.*—*Multifascigera campicheana* D'Orbigny, 1853. Cretaceous.

### MULTIFASCIGERA CAMPICHEANA D'Orbigny, 1853

Plate 6, fig. 9

1853. *Multifascigera campicheana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 688, pl. 762, figs. 7, 9.

This species is very remarkable in its structure and the size that it attains—6 centimeters in diameter. The zoarium is formed of superposed lamellae. Each lamella is supported on the fascicles of the inferior lamella, serving as pillars; it is formed of distinct subcolonies in the form of *Actinopora* or of *Lopholepis*, intimately joined together. Each of the subcolonies has a distinct origin and arises from a tube of a fascicle of the inferior lamella.

The section figured by D'Orbigny is incomplete, for it does not cut the basal portion of a subcolony and therefore does not show exactly the formation of the zoarium. A section properly made shows that the tubes are cylindrical, with dorsal gemmation, vertically elevated.

The fascicles are irregular, ovoid, rather short, irregularly multiserial. The specimen which we figure shows at the right a subcolony in the form of *Actinopora* and at the left a subcolony in the form of *Lopholepis*. The spaces between the fascicles are smooth. We have not been able to discover the ovicell.

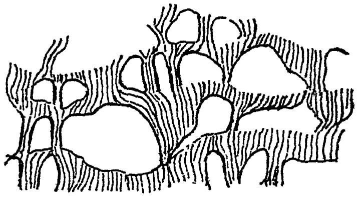


FIG. 30.—*Multifascigera campicheana* D'Orbigny, 1853. Transverse section, × 4, showing the origin of a superior subcolony. Lower Cretaceous (Valangian); Sainte-Croix, Switzerland

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotypes.*—Cat. No. 69909, U.S.N.M.

## Subdivision RECTANGULATA Waters, 1887

## Family LICHENOPORIDAE Smitt, 1866

### MULTIGALEA, new genus

The ovicell is elongate, star-shaped, with many branches; the branches are separated by uni- or biserial groups of zooecia. The tubes have an exterior, triangular, very fragile visor (=galea). The tubes are cylindrical, with dorsal gemmation, elevated in their superior half. The zoarium is composed of orbicular subcolonies irregularly superposed. The cancelli are small and denticulated in the interior.

*Genotype.*—*Multigalea* (*Reptomulticava*) *canui* Gregory, 1909. This new genus differs from *Radiopora* D'Orbigny, 1849, in the presence of ovicells and in the occurrences of visors on the tubes.

### MULTIGALEA CANUI Gregory, 1909

Plate 19, figs. 1–6

1854. *Reptomulticava tuberosa* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 1036, pl. 791, figs. 13, 14.

1909. *Reptomulticava canui* GREGORY, Catalogue of the Cretaceous, Bryozoa in the British Museum, vol 2, p. 128. (Bibliography.)

*Structure.*—The zoarial aspect is that shown in D'Orbigny's figure. The subcolonies are superposed and joined to each other by tubes of greater diameter. In each of them the tubes are arranged in quincunx. The visor is salient and triangular. The visors are very fragile; they disappear at the least weathering; then the tubes and cancelli are indistinguishable and appear as polygonal tubes with thickened walls of an aspect very similar to that of D'Orbigny's figure (14).

The ovicells are visible only in the protected parts of the zoarium. They have the usual aspect of the ovicells in the Lichenoporidae, but a remarkable phenomenon is that the tubes between which they are arranged are grouped in radial uni- or biserial lines and that on the zoarial surfaces the tubes are arranged in quincunx and never in lines or in fascicles with adjacent tubes.

In longitudinal sections the tubes are cylindrical, with dorsal gemmation; the cancelli are ramifications of more or less length and of a diameter almost equal to that of the tubes. The interior spines of the cancelli, although visible exteriorly, are very fragile and disappear in sections.

The subcolonies are little distinct in small zoaria.

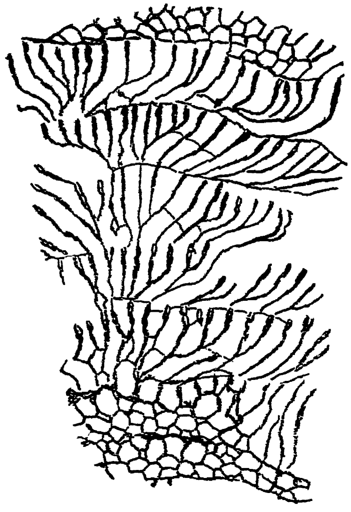


FIG. 31.—*Multigalea canui* Gregory, 1909. Longitudinal section, × 16. Lower Cretaceous (Aptian): Faringdon, England

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotypes.*—Cat. No. 69910, U.S.N.M.

## MULTIGALEA MARGINATA, new species

Plate 19, figs. 7–10

*Description.*—The zoarium is large, cylindrical, borne upon an expanded base. The subcolonies are orbicular, convex, *bordered* by a smooth lamella of more or less width. The tubes are polygonal, arranged in irregular quincunx, provided superiorly with a short and fragile visor. The cancelli are little distinct from the tubes.

*Affinities.*—This species differs from *Multigalea canui* Gregory, 1909, in its tubular walls little thickened and in the presence of smooth margins around the subcolonies.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69911, U.S.N.M.

### Genus THOLOPORA Gregory, 1909

#### THOLOPORA VIRGULOSA Gregory, 1909

Plate 20, fig. 1

1909. *Tholopora virgulosa* Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 277. (Bibliography, geologic distribution.)

Our fine specimen corresponds very well to the figures of Goldfuss, 1829, and of Simonowitsch, 1871. It differs from the isolated colonies of *Tholopora colligata* Gregory, 1909, in the smaller diameter of its aperture (0.12 mm. and not 0.20 mm.).

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotype.*—Cat. No. 69912, U.S.N.M.

### Genus RADIOPORA D'Orbigny, 1849

#### RADIOPORA TUBERCULATA D'Orbigny, 1850

Plate 20, figs. 2–5

1909. *Radiopora tuberculata* Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2 p. 288, pl. 4, fig. 8. (Bibliography, geologic distribution.)

Diameter of the orifices, 0.16–0.20 mm.

This species is well characterized by the large size of its aperture. The zoarium is formed of many superposed lamellae of orbicular subcolonies. The study of the inferior face is interesting; it shows that the larva fixes itself on a grain of quartz and that the basal gemmation operates fan-shaped fashion as in *Berenicea.*

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Plesiotype.*—Cat. No. 69913, U.S.N.M.

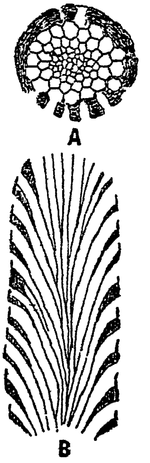


Fig. 32.—*Lobosoecia semiclausa* Michelin, 1845. A. Transverse section, × 16. B. Longitudinal section, × 16, at the extremity of a branch. The tubes are widened and have dorsal gemmation. Cretaceous: Lemans, France

## Family LOBOSOECIIDAE Canu and Bassler, 1922

### Genus LOBOSOECIA Canu and Bassler, 1922

#### LOBOSOECIA SEMICLAUSA Michelin, 1845

Plate 14, figs. 12–13

1922. *Lobosoecia semiclausa* Canu and Bassler, Studies on the Cyclostomatous Bryozoa, Proceedings U. S. National Museum, vol. 61, p. 81, pl. 12, figs. 4–11. (Bibliography.)

*Measurements.*—

$$\text{Aperture}\left\{\begin{matrix}\text{ha}=0.08\text{ mm.}\\ \text{la}=0.09\text{ mm.}\end{matrix}\right\}\text{Facettes}\left\{\begin{matrix}\text{hf}=0.24\text{ (max. 0.30) mm.}\\ \text{lf}=0.20\text{ (max. 0.30) mm.}\end{matrix}\right.$$

Diameter of branches, 1 mm. Our specimen from Faringdon shows facettes a little longer than 0.32 by 0.20 mm. If it belongs to this species it should possibly be considered as a variety.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (very rare).

*Plesiotype.*—Cat. No. 69914, U.S.N.M.

## Family ELEIDAE D'Orbigny, 1852

### Genus MELICERITITES Roemer, 1840

### MELICERITITES HAIMEANA D'Orbigny, 1853

Plate 13, figs. 18–20

1853. *Entalophora haimeana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, pl. 617, figs. 11–14.
1853. *Melicerititės haimeana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 618.
1889. *Melicerititės haimeana* PERGENS, Revision des Bryozoaires du Crétacé figures par D'ORBIGNY, Memoires Société Belgé de Geologie, etc., vol. 3, p. 399.

Pergens, 1889, notes that the specimens in the Museum of Paris seem worn. This is in effect the habitual aspect of this species and such specimens are in reality normal. Those which we have found at Faringdon correspond very well with D'Orbigny's figure and description. The facettes are separated by furrows and not by salient threads. Certain specimens seem to be multilamellar.

*Measurements.*—

$$\text{Aperture}\begin{cases}\text{ha}=0.06\text{ mm.}\\ \text{la}=0.08\text{ mm.}\end{cases}\text{Facettes}\begin{cases}\text{hf}=0.30\text{ mm.}\\ \text{lf}=0.16\text{ mm.}\end{cases}$$

Diameter of branches, 1.20 mm.

*Occurrence.*—Lower Cretaceous. Albian, Grandpré (Ardennes), France; Aptian, Faringdon, England (very common).

*Plesiotypes.*—Cat. No. 69915, U.S.N.M.

### MELICERITITES TRANSVERSA, new species

Plate 12, figs. 1–12

*Description.*—The zoarium is free, cylindrical, ramified, borne on a little expanded base, formed of many superposed lamellae. On the central zoarium the peristomes are salient, adjacent laterally, and arranged in close transverse rows; the facettes are quite short and separated by very short threads. The aperture is triangular, somewhat transverse. The ovicell is very short, *transverse*, occupying all the zoarial width, quite convex, smooth; the oeciostome is a little salient tube. On the exterior lamellae the peristomes are arranged in quincunx; on the basal lamella they are little salient and almost orbicular.

*Measurements.*—

$$\text{Aperture}\begin{cases}\text{ha}=0.08\text{ mm.}\\ \text{la}\ =0.10\text{ mm.}\end{cases}\text{Facettes}\begin{cases}\text{hf}=0.20\text{–}0.26\text{ mm.}\\ \text{lf}\ =0.16\text{ mm.}\end{cases}$$

Diameter of zoaria at the extremity, 1.5 mm.; diameter of zoaria at the base, 2.1 mm.; length of ovicell, 0.64 mm.

*Variations.*—When the peristomes are very salient the facettes are little visible (figs. 2, 3). On the same branch the peristomes may be salient or not (fig. 4), in transverse regular rows (fig. 4), irregular (fig. 5), or oblique (fig. 6). On the exterior lamellae the peristomes are arranged in quincunx (figs. 7, 8). The facettes are visible only on the specimens with little salient peristomes (figs. 4, 7). On the basal lamellae the peristomes are little salient and almost orbicular (fig. 10). The incrusting exterior lamellae are enveloping subcolonies of reenforcement.

The longitudinal section shows a central bundle of very long cylindrical tubes emitting laterally by dorsal gemmation, short tubes narrowed at the base but much expanded in their recurved terminal part.

In transverse section the central bundle is formed by several large tubes around which are smaller tubes representing the base of the tubes with facettes.

The opercula are very rare. We have observed some cases of regeneration.

*Affinities.*—This species resembles greatly *Meliceritites foricula* D'Orbigny, 1853, of the French Turonian. It differs in the transverse aperture and in the transverse and not elongated ovicell.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (very common).

*Cotypes.*—Cat. No. 69916, U.S.N.M.

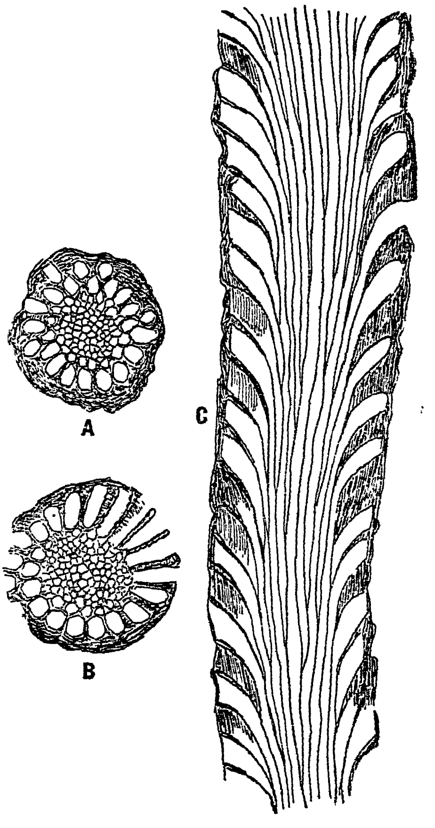


FIG. 33.—*Meliceritites transversa*, new species A. Transverse section, × 16, made between the orifices. The peristomes were in transverse somewhat oblique rows which causes the helicoidal arrangement of the peripheral tubes. B. Transverse section, × 16, cutting some orifices. C. Longitudinal section, × 16. The clear tubes are cut along the median axis while the shaded ones are cut tangentially to their walls, this arrangement resulting from the disposition of the peristomes in transverse rows. At the center is a long tube which may branch. Lower Cretaceous (Aptian): Faringdon, England

### MELICERITITES CUNNINGTONI Gregory, 1899

Plate 13, figs. 1–8

1899. *Nodelea cunningtoni* GREGORY, Catalogue of Cretaceous Bryozoa in the British Museum, vol. 1, p. 308, figs. 35, 36.

*Variations.*—Gregory, 1899, gave an incomplete description of this species. The orifices are transverse; the peristomes are thin, adjacent, arranged in transverse rows (fig. 2) and more rarely in quincunx (fig. 6). Opercula are frequent (fig. 2).

The eleocellaria are ordinary zooecia in which the aperture is elongated and presents two lateral denticles (fig. 4).

The chief characteristic of this species is the frequent presence of a tranverse fossette placed below the aperture (fig. 5). The fusion of this fossette with the aperture engenders the eleocellarium (fig. 4). The longitudinal section of this species has been figured by Gregory, 1899. The ovicell is unknown. Figure 7 represents an arrest of development, resulting in a false base.

*Measurements.*—

$$\text{Aperture}\left\{\begin{matrix}ha=0.16\text{–}0.18\text{ mm.}\\ la=0.20\text{ mm.}\end{matrix}\right\}\quad\text{Facettes}\left\{\begin{matrix}hf=0.44\text{ mm.}\\ lf=0.44\text{ mm.}\end{matrix}\right.$$

Diameter of the branches, 3 mm.

*Affinities.*—This species is very well characterized by the nature of its eleocellaria and by the transverse fossettes which adorn a certain number of zooecia.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Plesiotype.*—Cat. No. 69917, U.S.N.M.

### MELICERITITES SEMICLAUSA Gregory, 1899

Plate 11, figs. 12, 13

1872. *Meliceritites gracilis* Reuss, Die Bryozoen und Foraminiferen des unteren Planers, Paleontographica, vol. 20, pt. 1, p. 120, pl. 29, figs. 12–16 (not synonymy).

1899. *Meliceritites semiclausa* (part) Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 328, pl. 14, fig. 2 (not figs. 1, 3).

*Affinities.*—Our examples correspond almost exactly in aspect and measurements with the specimen figured by Gregory (pl. 14, fig. 2), the single slight difference being in the more elongate form of the eleocellarium.

The ovicell belongs to the group of *Meliceritites transversa* in its great width. Unfortunately, the ovicell of our figured specimen was broken.

The species differs from *Lobosoecia semiclausa* Michelin, 1845, in its much larger micrometric measurements, in the presence of an eleocellarium, and in its semicircular aperture.

*Measurements.*—

$$\text{Aperture}\left\{\begin{matrix}ha=\ ?\\ la=0.12\text{–}0.16\text{ mm.}\end{matrix}\right\}\quad\text{Facettes}\left\{\begin{matrix}hf=0.40\text{–}0.48\text{ mm.}\\ lf=0.27\text{–}0.30\text{ mm.}\end{matrix}\right.$$

Diameter of large branches, 2 mm.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Geological distribution.*—Lower Cretaceous (Cenomanian): Le Mans (Sarthe), France, Warminster, England, and Plauen, Germany.

*Plesiotype.*—Cat. No. 69918, U.S.N.M.

#### MELICERITITES, species undetermined

Plate 12, figs. 13–15

We have found two very curious specimens of *Melicerítites*, one with all the facettes perforated and the other with some of them perforated. These perforations are enigmatical. We believe the specimen worthy of illustration, but we are unable to affirm that they belong to a special species until a larger number of examples has been collected.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

Cat. No. 69919, U.S.N.M.

## Subdivision RECTANGULATA

## Family CERIOCAVIDAE Canu and Bassler, 1922

### Genus CERIOCAVA D'Orbigny, 1852

(See Canu and Bassler, 1922, for definition)

#### CERIOCAVA GRANDIPORA, new species

Plate 9, figs. 14–17

*Description.*—The zoarium is free, arborescent, formed of cylindrical or compressed branches; the base is quite small, orbicular, nonadherent to the substratum. The orifices are *large*, polygonal, arranged in quincunx or in transverse rows. The ovicell is capsule-shaped, deep, digitate, with an exterior concave and smooth surface.

*Measurements.*—Diameter of orifice, 0.32–0.40 mm.; diameter of large branches, 4 mm.

*Affinities.*—This species is well characterized by the large size of its orifices and by its digitate ovicell. In the Jurassic species the ovicells are entire and nondigitate.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

*Cotypes.*—Cat. No. 69920, U.S.N.M.

#### CERIOCAVA JUNCTATA, new species

Plate 9, figs. 11–13

*Description.*—The zoarium is hollow, cylindrical, formed of fragments irregularly *joined* together or anastomosing; the branches are solid, with the normal section. The orifices are elliptical, placed at the bottom of a polygonal peristome; they are arranged in quincunx.

*Measurements.*—Diameter of interior orifice, 0.16 by 0.20 mm.; diameter of exterior orifice, 0.22 mm.; diameter of branches, 2.5 mm.

*Structure.*—The basal parts of the zoarium have the *Semicava* growth of D'Orbigny, but the branches which they emit are solid and their sections are identical with those of *Ceriocava.*

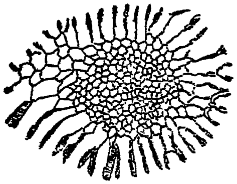


FIG. 34.—*Ceriocava junctata*, new species. Transverse section, × 16, through a solid cylindrical branch. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

It is difficult to predict the direction of the tubes in an incrusting colony in order to section it correctly.

In tangential section it may be noted that the tubes are polygonal, adjacent, but their interior is calcified and thus forms a rounded interior tube.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (rare).

*Cotypes.*—Cat. No. 69921, U.S.N.M.

### CERIOCAVA MULTILAMELLOSA, new species

Plate 9, figs. 1–10

*Description.*—The zoarium is free, cylindrical, dichotomous, formed of many enveloping lamellae; the outermost lamellae are incomplete and show at their extremity a short zone of growth. The facettes are hexagonal, arranged in transverse rows, perforated at the center by the aperture. The aperture is orbicular and surrounded by a thin and somewhat salient peristome. The orifices of the tubes without facettes are irregularly polygonal.

*Measurements.*—Diameter of apertures, 0.08 mm.; diameter of peristomes, 0.10 mm.; diameter of facettes, 0.16 mm.; diameter of larger branches, 2.5 mm.

*Structure.*—The extremity of the branches is conical, as in all colonies in which the tubes are expanded. This conical part is considered as the zone of growth and the orifices here do not bear facettes (fig. 3).

The exterior lamellae grow around the interior trunk and appear around it as a rather thick but short zone of growth (fig. 2); these lamellae bear facettes like the central trunk.

The facettes are often well distributed over all the colony (figs. 2, 3), but frequently they appear only in zones (fig. 5). We can not affirm that their existence is normal, for entire branches are deprived of them and seem even never to have had them (fig. 9). The appearance of facettes in the genus *Ceriocava* still remains a mystery. Perhaps they are very fragile, as in *Melicerilites*, and disappear easily by slight abrasion.

The longitudinal section of the extremity of a young branch shows the disappearance of the central bundles of tubes, the latter expanding in fan-shape around the zoarial axis. A longitudinal section made through a branch with facettes was not very successful, as silicification had invaded the tubes of the exterior lamella. The peristomes were arranged in quincunx and the tube appeared with thickened walls without any of them having been sectioned tangentially. In transverse section the central bundle is quite apparent.

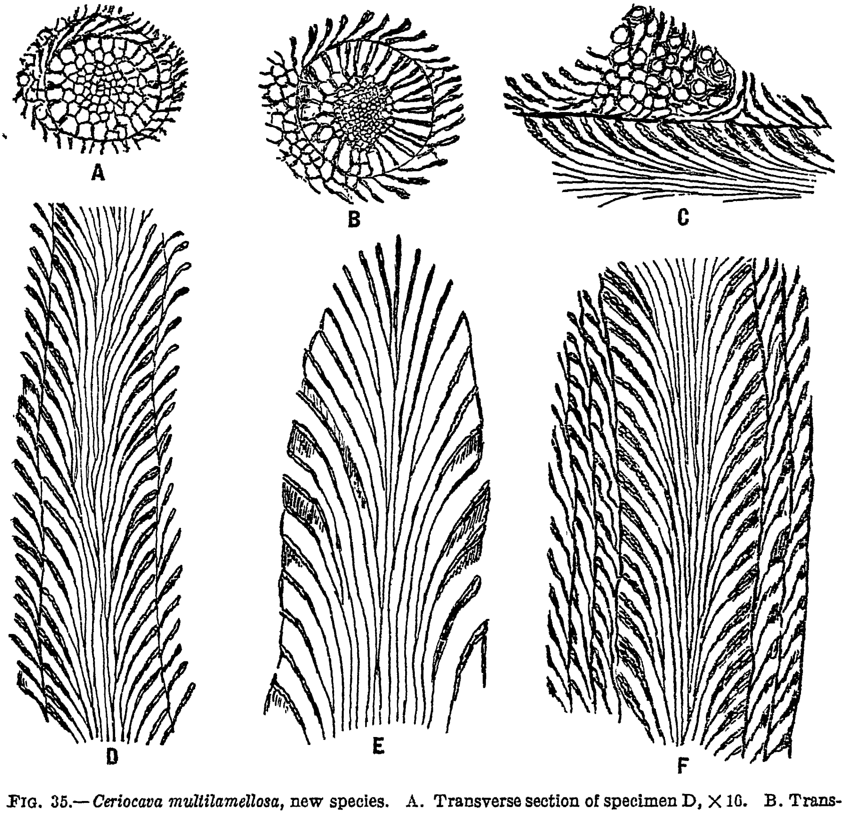


FIG. 35.—*Ceriocava multilamellosa*, new species. A. Transverse section of specimen D, × 16. B. Transverse section, × 16. C. Section through a branch, × 16, in which the exterior lamella is engendering an adventitious branch. D. Longitudinal section (see also A), × 16, in which the orifices are arranged in quincunx. E. Longitudinal section, × 16, at the extremity of a branch. F. Longitudinal section, × 16, through a multilamellar branch. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

We have had the fortune to find a branch containing these supposed lamellae with their zone of growth. The longitudinal section of this branch shows that the tubes are arranged in a different direction from that of the interior lamella; their extremity is alone visible and they appear there shorter than they are in reality. The study of the transverse section confirms this arrangement.

The exterior lamellae could become elevated to form false ramifications.

The longitudinal section shows a number of tubes cut tangentially and appearing in gray or in black. The facettes were in reality arranged regularly in transverse rows.

In *Ceriocava* the longitudinal section has different aspects according as the facettes are arranged in quincunx or transversely. This obsvervation was known, but it is important that it has been confirmed on the same species.

The central tubes grow by axial gemmation around a single tube which branches only at the bifurcations of the branches. This tube appears in transversal sections with a larger diameter.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69922, U.S.N.M.

### CERIOCAVA INGENS, new species

Plate 8, figs. 8–12

*Description.*—The zoarium is free, *large*, arborescent; the branches are compressed or cylindrical. The facettes are distinct, separated by a furrow of little depth, somewhat convex, smooth, arranged in quincunx, pierced at the middle by the aperture. The aperture is orbicular and surrounded by a thin, little salient peristome. The orifices of the tubes without facettes are large and irregularly polygonal.

*Measurements.*—Diameter of aperture, 0.14 mm.; diameter of peristome, 0.17 mm.; diameter of facettes, 0.30–0.40 mm.; diameter of orifices without facettes, 0.20 mm.; diameter of zoarium, 10 mm.

*Affinities.*—As in all species of the genus, the orifice of the tubes without facettes is expanded; it measures internally at the base of the visible peristomie 0.17 mm., but externally its diameter is about 0.40 mm., exactly equal to that of the tubes with facettes.

The species differs from *Diplocava inordinata* in its monomorphic zooecia, its large zoarium, and its much larger micrometric measurements. On the figured specimen the tubes with facettes are at the bottom of the zoarium; the branches are deprived of them.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

*Cotype.*—Cat. No. 69923, U.S.N.M.

### CERIOCAVA TENUIRAMA, new species

Plate 10, figs. 1–4

*Description.*—The zoarium is free, cylindrical, bifurcated, formed of *small branches*. The orifices of the tubes without facettes are lozenge-shaped, elongated, arranged in transverse rows. The orifices of the tubes with facettes are terminal, orbicular, with a peristome thin and little salient; the facettes are elongated, hexagonal, little distinct.

*Measurements.*—Diameter of peristomes, 0.14–0.16 mm.; diameter of orbicular orifices, 0.10 mm.; diameter of lozenge-shaped orifices, 0.06–0.08 mm.; diameter of branches, 1 mm.

*Affinities.*—This new species differs from *Ceriocava multilamellosa* in its smaller branches, in the lozenge-shaped tubes without facettes, and in the terminal position of the orifices on the facettes.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69924, U.S.N.M.

### DIPLOCAVA, new genus

Ceriocavidae with dimorphic zooecia.

*Genotype.*—*Diplocava incondita,* new species. Lower Cretaceous (Neocomian). In this genus tubes without facettes and much larger dimensions appear. They are most frequently in more or less orbicular and salient groups; rarely they are scattered. They are not constant, and it is not rare to discover zoarial fragments which lack them. The determination of species of this genus is therefore very difficult, especially on isolated specimens. The ovicell has not yet been discovered.

### DIPLOCAVA INCONDITA, new species

Plate 10, figs. 5–12

*Description.*—The zoarium is free, dichotomous, in unilamellar fronds or in *irregularly* cylindrical, multilamellar fragments. The large zooecia are always open, grouped in salient orbicular areas which are separated from each other by zones of small zooecia with facettes. The facettes are hexagonal, distinct, separated by a furrow, convex, smooth, perforated in the middle. The apertura is large, orbicular, surrounded by a thin and salient peristome. The ovicell is star-shaped, with four branches, placed in the midst of the large tubes.

*Measurements.*—Diameter of aperture, 0.14 mm.; diameter of peristome, 0.20 mm.; diameter of facettes, 0.30 mm.; diameter of external orifice of large tubes, 0.30 mm.; diameter of external orifice of small tubes, 0.20 mm.; diameter of the large branches, 5 mm.

*Variations.*—This species is very irregular in its external aspect. We have observed some lamellar fragments simple or double with monomorphic zooecia, arborescent fragments formed of small tubes only, fragments formed of tubes with facettes only, irregular fragments formed of an inner trunk of zooecia with facettes, covered over with irregular lamellae with open dimorphic zooecia. The normal aspect is that which shows salient groups of large zooecia surrounded by variable zones of small zooecia with facettes; these zones may become very large.

A longitudinal section taken at the extremity of a large branch shows the tubes expanded and recurved at their extremity, with axial gemmation around a large central ramified tube. The small tubes are grouped in special zones. The walls of the tubes are moniliform in their recurved parts.

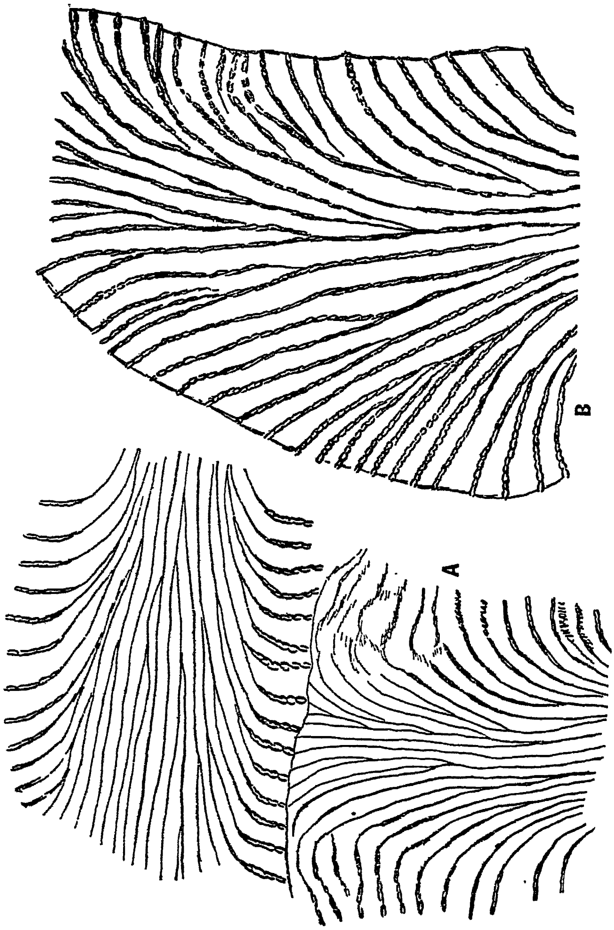


FIG. 36.—*Diplocava incondita*, new species. A. Longitudinal section, × 16, through a specimen with two joined branches. B. Longitudinal section, × 16, through the extremity of a branch in which the tubes have facettes. The walls are hollow and moniliform. Lower Cretaceous (Valanginian): Sainte-Croix, Switzerland

A fragment which exteriorily appeared regularly branched showed in longitudinal section the union of two fragments of different origin.

Finally, a meridian section in a large irregular zoarium shows an extreme complication occasioned by the multiplicity of the enveloping lamellae.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland (common.)

*Cotypes.*—Cat. No. 69925, U.S.N.M.

### DIPLOCAVA INORDINATA, new species

Plate 11, figs. 1–5

*Description.*—The zoarium is free, cylindrical, arborescent; the base is enlarged and placed on a substratum. The large tubes appear very irregularly among the others, sometimes isolated, sometimes grouped. The facettes are hexagonal, little visible, smooth, very little convex, perforated at the middle by the aperture. The aperture is orbicular, large or small, according to the nature of the tubes, surrounded by a peristome which is scarcely salient and very thin. The orifices of the tubes without facettes are polygonal.

*Measurements.*—Inner orifice of small tubes, 0.16 mm.; diameter exterior orifice of small tubes, 0.20 mm.; diameter inner orifice of large tubes, 0.20–0.24 mm.; diameter exterior orifice of large tubes, 0.30 mm.; diameter aperture, small tubes with facettes, 0.10 mm.; diameter aperture, large tubes with facettes, 0.14 mm.; diameter of the large branches, 3 mm.

*Variations.*—As our specimens are numerous, we have been able to study the variations. We have observed zoarial fragments formed uniquely of large (fig. 3) or small (fig. 2) zooecia, fragments with both kinds of zooecia (fig. 4), and finally a fragment with tubes bearing facettes (fig. 5).

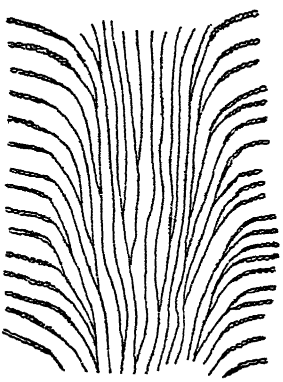


FIG. 37.—*Diplocava inordinata*, new species. Longitudinal section, × 16, exhibiting the variations in diameter of the tubes at their extremity. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

In longitudinal sections the tubes have a diameter quite variable in their recurved expanded parts.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (common).

*Cotypes.*—Cat. No. 69926, U.S.N.M.

### DIPLOCAVA ORBICULIFERA, new species

Plate 11, figs. 6–8

*Description.*—The zoarium is free, cylindrical, ramose. The large tubes are grouped in very regular *orbicular* areas irregularly arranged on the zoarium. The small tubes are much more numerous, hexagonal, arranged in quincunx.

*Measurements.*—Diameter orifice of small tubes, 0.10 mm.; diameter of large tubes, 0.20 mm.; diameter of zoarium, 10 mm.

*Affinities.*—This species differs from *Diplocava incondita* in its larger zoarium, in the smaller measurements, and in the considerable separation of the groups of large tubes. It differs from *Diplocava globulosa* in its arborescent zoarium and in the separation of the groups of larger tubes.

The sections show the usual structure of *Diplocava*. They indicate that the central colony may be covered over by an exterior incrusting lamella.

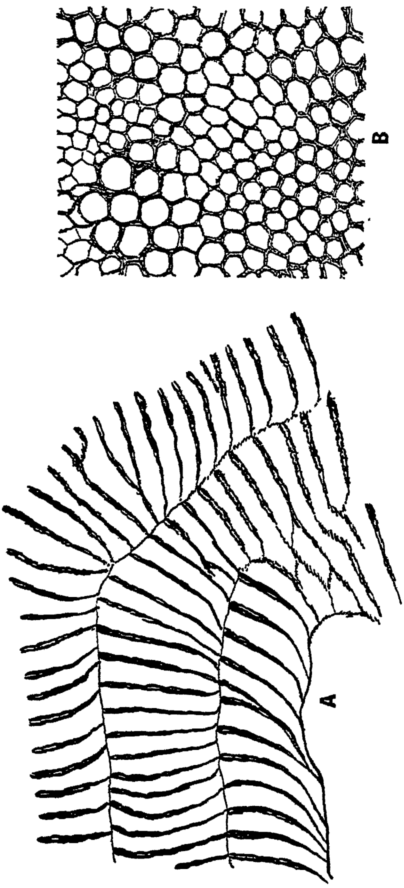


FIG. 38.—*Diplocava globulosa*, new species. A. Meridian section, × 16, showing the many enveloping lamellae. B. Tangential thin section, × 16. Dimorphism occurs. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

*Cotype.*—Cat. No. 69927, U.S.N.M.

### DIPLOCAVA GLOBULOSA, new species

Plate 11, figs. 9–11

*Description.*—The zoarium is a globular multilamellar mass; it is free or incrusts shells (*Semimulticava*). The large cells are grouped in orbicular spaces which are somewhat convex. The small zooecia form zones of more or less width around each group of large orifices.

*Measurements.*—Diameter interior of large tubes, 0.16 mm.; diameter interior of small tubes, 0.10 mm.; diameter of zoarium, 10 mm.

*Structure.*—In sectioning the elliptical zoarium along the large axis one would expect to cut the zooecia along their length, but this does not happen, as the section cuts only the expanded extremity of the tubes. In this genus the direction of the tubes is absolutely independent of the zoarial form and the direction can only be surmised from the exterior. As may be readily observed, the large tubes occur only in the convex portions, while the small tubes are limited to the concave portions; the difference between them is of little importance.

In tangential section the tubes are rounded and included in the thick hexagonal walls. The difference in size between the large and the small tubes is quite considerable. According to these two latter observations, it might be concluded that the dimorphism observed in *Diplocava* is more apparent than real and that it occurs only at the terminal part of the tubes.

*Affinities.*—This species differs from *Diplocava incondita* in its non-arborescent zoarium, its smaller micrometric dimensions, and in its less apparent dimorphism.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland (very rare).

*Cotype.*—Cat. No. 69928, U.S.N.M.

### Cenus SPIROCLAUSA D'Orbigny, 1852

#### SPIROCLAUSA NEOCOMIENSIS De Loriol, 1863

Plate 11, fig. 14

1863. *Spiroclausa neocomiensis* DE LORIOL, Les Invertébrés du Neocomien inférieur du Mont Salève pres Genève, p. 137, pl. 17, fig. 5.

Our figured specimen does not much resemble that of De Loriol, but not being able to make sections, we do not believe we ought to create a new species for it.

Its relationships seem to us to be with the *Diplocava,* for the superior tubes of the spires are much larger than the others. In each spire there is always one or more circles of inclosed zooecia.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix (Vaud), Switzerland.

*Plesiotype.*—Cat. No. 69929, U.S.N.M.

## Family LEIOSOECIIDAE Canu and Bassler, 1920

### Genus LEIOSOECIA Canu and Bassler, 1920

#### LEIOSOECIA AEQUIPOROSA, new species

Plate 16, figs. 15–18

*Description.*—The zoarium is free, cylindrical. The orifices are suborbicular and slightly polygonal; the peristomes are thick, non-salient, arranged in quincunx. The mesopores are little numerous, irregular, polygonal, equal to the apertures. The ovicell is large, orbicular or somewhat elliptical, thin, very convex.

*Measurements.*—Diameter of orifices, 0.10 mm.; diameter of mesopores, 0.08–0.10 mm.; diameter of zoarium, 2.5 mm.

*Structure.*—In longitudinal section the tubes are cylindrical. The mesopores are rare, rather long, with thickened, hollow or moniliform walls.

In transverse section the tubes are polygonal, with adjacent walls. The thickening of the walls of the mesopores forms a thick parietal zone.

In tangential section the mesopores are smaller than the tubes because their orifice is infundibuliform; they are separated by a thick, lamellose tissue.

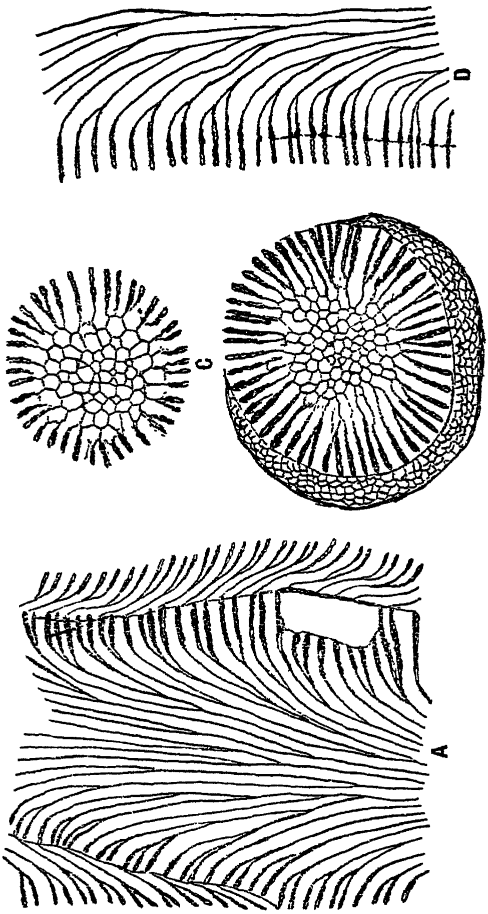


FIG. 39.—Genus *Leiosoecia* Canu and Bassler, 1920. A–B. *Leiosoecia proxima*, new species. A. Longitudinal section, × 16, through a specimen with an extra lamellar layer. B. Transverse section, × 16, of the same specimen. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland. C. *Leiosoecia aequiporosa*, new species. Transverse thin section, × 16. Lower Cretaceous. D. *Leiosoecia grandipora*, new species. Longitudinal thin section, × 16, showing the rarity of mesopores. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

*Affinities.*—This species differs from *Leiosoecia grandipora*, in which the mesopores have the same dimension, in the smaller zoarium, in the smaller aperture (not 0.12 mm.), and in the less regular ovicell.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland (rare).

*Cotype.*—Cat. No. 69930, U.S.N.M.

### LEIOSOECIA GRANDIPORA, new species

Plate 16, figs. 1-4

*Description.*—The zoarium is free, cylindrical, bifurcated. The orifices are polygonal; the peristomes are thin, nonsalient. The mesopores are large, polygonal, few in number, irregularly placed. The ovicell is large, orbicular, convex, smooth.

*Measurements.*—Diameter of aperture, 0.12 mm.; diameter of mesopores, 0.10 mm.; diameter of zoarium, 4 mm.

*Structure.*—In longitudinal section the tubes are cylindrical, with very thick walls, recurved at their extremity, with axial gemmation. The mesopores have a variable length; they appear at all heights and their distinction from the tubes is very difficult; they appear little numerous.

In transverse section the tubes are polygonal, with adjacent walls, as large at the center as at the periphery. The terminal thickening of the tubes and of the mesopores forms a thick parietal zone.

*Affinities.*—The species differs from *Leiosoecia aequiporosa* in its apertural diameter of 0.12 mm. and in its larger zoaria.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland (rare).

*Cotypes.*—Cat. No. 69932, U.S.N.M.

### LEIOSOECIA CONSTANTI D'Orbigny, 1850

Plate 17, figs. 1-5

1850. *Certopora constanti* D'ORBIGNY, Prodrome de Paléontologie, vol. 2, p. 143.
1854. *Heteropora constanti* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 1071, pl. 799, figs. 6, 7.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of peristome, 0.14 mm.; diameter of mesopores, 0.06 mm.; diameter of terminal branches, 3 mm.; diameter of large branches, 7 mm.

*Structure.*—We have found very typical specimens corresponding to D'Orbigny's figures. They have, indeed, polygonal orifices surrounded by small mesopores. Moreover, the zoarial surface presents undulations and in places circular areas of mesopores.

Other specimens, less typical in appearance, have the same apertural diameter, the same orbicular area of mesopores, the same characters in longitudinal section, but the zoaria lack the undulations, and the mesopores (0.07, 0.08 mm.) are a little larger.

It is difficult to recognize two species in these specimens. The first lot seems to us to be the terminal branches, the second, moreover, larger, are the large adult branches. On the other hand, on the same specimen it is easy to observe the variations in the size of the mesopores.

In longitudinal sections the tubes are cylindrical, with rather regular peripheral gemmation. The mesopores are rather long and little numerous. There are zonal lines, rather regular, very convex, scattered in the inferior part of the branches and approaching more closely at the summit. The zoarial margins are occupied by epithecal lines, very numerous, close together, represented in a drawing with difficulty. The diaphragms are widely spaced and their simultaneous occurrence forms the zonal lines. The extremity of the tubes is thickened and moniliform; the tubes are not then rigorously cylindrical but show constrictions more and more close to each other.

In transverse sections the tubes are polygonal, with thin and adjacent walls. On the edge the epithecal lines are so close together that they form an exterior epithecal zone so opaque that photography can show its complexity only imperfectly.

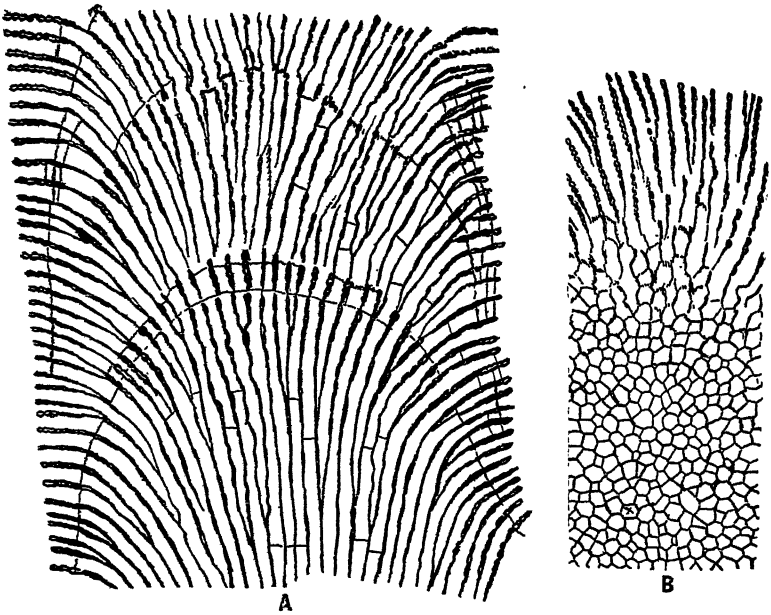


FIG. 40.—*Leiosoecia constanti* D'Orbigny, 1850. A. Longitudinal section, × 16, showing the zonal lines and the undulated tubes with their diaphragms. B. Portion of a transverse section, × 16, illustrating the polygonal form of the tubes. Lower Cretaceous (Valangian): Sainte-Croix, Switzerland

In tangential section the tubes are little polygonal and the mesopores are very small. The calcareous tissue which surrounds them is alveolar.

This species has the same internal structure as *Leiosoecia multiporosa* and *Leiosoecia grandipora*, but the zonal lines and the epithecal lines are more numerous.

*Occurrence.*—Lower Cretaceous: Sainte-Croix, Switzerland (Valangian); Grandpré (Ardennes), France (Aptian).

*Plesiotypes.*—Cat. No. 69933, U.S.N.M

### LEIOSOECIA PROXIMA, new species

Plate 17, figs. 12–15

*Description.*—The zoarium is free, subcylindrical, bifurcated. The orifices are orbicular or subpolygonal, with salient peristomes. The mesopores are polygonal, smaller than the apertures, few in number. The ovicells are orbicular, very convex, smooth.

*Measurements.*—Diameter of aperture, 0.10–0.12 mm.; diameter of mesopores, 0.08 mm.; diameter of zoarium, 4 mm.

*Affinities.*—In its exterior aspect this species is *very close* to *Leiosoecia constanti* D'Orbigny, 1854. We believe, however, they are distinct. The zoarium is, in fact, multilamellar, as the longitudinal and transverse sections prove. There are no epithecal lines. Finally, in spite of irregularity of the specimens, the gemmation is peripheral but more axial and the central bundle of tubes is smaller.

Our longitudinal section is very interesting, as it shows the beginning of the exterior lamella. This is a tube which is prolonged on the surface of the primitive trunk which in turn is covered by the proliferation of its successive ramifications by dorsal gemmation. The phenomenon is then absolutely identical with that of lamellate *Reptomulticrescis* forms. It is thus proved that in such zoarial forms as *Heteropora*, *Reptomulticrescis*, and *Reptomulticava* there are two kinds of gemmation, dorsal and peripheral.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland (rare).

*Cotypes.*—Cat. No. 69931, U.S.N.M.

## Family CLAUSIDAE D'Orbigny, 1854

### Genus CLAUSA D'Orbigny, 1854

### CLAUSA CRANEI, new species

Plate 17, figs. 6, 7

*Description.*—The zoarium is free, claviform. The peristomes are thin, nonsalient, arranged in interrupted transverse lines, and separated by small numerous, polygonal dactylethrae.

*Measurements.*—Diameter of orifice, 0.08 mm.; diameter of peristome, 0.10 mm.; diameter of zoarium, 1 mm.

*Affinities.*—Only the type specimen has been found, and we have figured it not only because of its perfect preservation but in order to show that the genus *Clausa* appears to be well represented in the Lower Cretaceous, where it has hitherto never been noted.

The species differs from *Clausa zonifera*, new species, in its peristomes not grouped in zones and in its smaller orifices. The specific name is in honor of W. E. Crane, who collected the fine bryozoan fauna here described from Faringdon.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (very rare).

*Holotype.*—Cat. No. 69934, U.S.N.M.

### CLAUSA ZONIFERA, new species

Plate 17, figs. 8–11; Plate 31, fig. 9

*Description.*—The zoarium is free, cylindrical, borne upon a slightly expanded base, branching dichotomously in the same plane; the branches are cylindrical, rarely claviform. The peristomes are very thin, nonsalient, grouped in irregular zones, and separated by polygonal dactylethrae few in number. The tubes are cylindrical, with peripheral gemmation regularly developed around a central axis and at all heights. The ovicell is unknown.

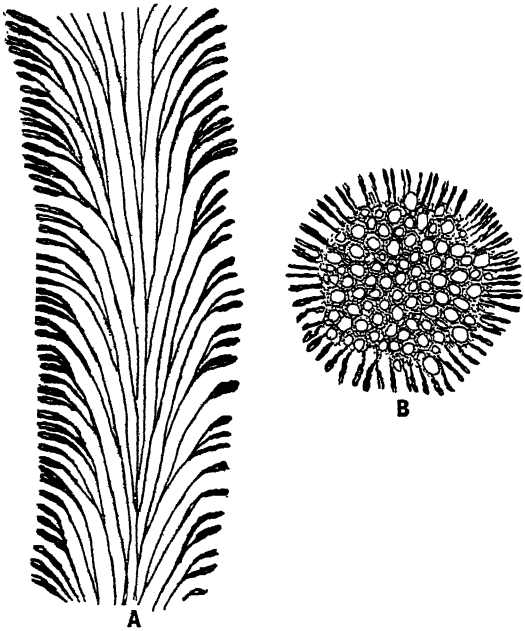


FIG. 41.—*Clausa zonifera*, new species. A. Longitudinal section, × 16. The dactylethrae are produced by dichotomous branching of the walls (peripheral gemmation). B. Transverse section, × 16. The dispersion of the small tubes among the large ones show that gemmation occurs at all distances from the central axis by regular peripheral dichotomous branching. Lower Cretaceous (Aptian): Faringdon, England

*Measurements.*—Diameter of orifice, 0.12 mm.; diameter of peristome, 0.15 mm.; diameter of large branches, 2.50 mm.

*Structure.*—Exteriorly this species has the appearance of a *Zonopora*. The grouping of the peristomes in circular zones is a deceptive generic character because it does not always correspond to the same internal structure. It is the same as in the clavulate zoarial form; indeed, in this species we have observed this form, although rarely, and we figure a superb unbranched specimen.

In longitudinal sections the tubes are cylindrical, recurved at their extremity, more or less long according to their distance from the central axis, and narrowed at their base. Their walls divide in two, engendering thus a new tube. This is the usual method of gemmation in the heteroporoids (peripheral). The peripheral tubes are thus shorter and shorter; a certain number aborted (by the disappearance of the polypide), closed by a calcareous pellicule and become the dactylethrae. An examination of the extremity of a branch also reveals the same heteroporoid structure, This feature has been described by D'Orbigny, 1852, and by Gregory, 1899, who have established the family Clausidae upon it.

In transverse section the tubes are polygonal, with thickened walls, a little larger toward the periphery. Among the large tubes appear smaller tubes irregularly scattered; these are newly formed young tubes whose thin base is thus sectioned. The dactylethrae appear as smaller tubes visible only at the periphery.

In tangential sections the tubes are polygonal, with thick and adjacent walls but in which the interior is rounded. The dactylethrae are smaller and their interior remains polygonal.

*Affinities.*—This is the only species of the Clausidae in which the peristomes are grouped in circular zones separated by narrower zones of dactylethrae. This simple exterior character is sufficient to distinguish it from other species of the Cretaceous and notably from *Clausa heteropora* D'Orbigny, 1851, very commonly observed in the Cenomanian of Europe, as well as *Clausa cranei,* new species.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Cotypes.*—Cat. No. 69935, U.S.N.M.

### Genus **REPTOCLAUSA** D'Orbigny, 1853

1853. *Reptoclausa* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 887.

Based on historic considerations and the right of priority, Gregory in 1897 classified the species of this genus in *Idmonea* Lamouroux, 1821. The zoologists have not yet admitted this classification, which would necessitate a complete rearrangement of the bibliography relative to *Idmonea.* We have nothing to add to this discussion, and while awaiting a decision on the question as to whether *Idmonea* was clearly defined we will continue to follow the principle of least change. We will preserve, therefore, D'Orbigny's name for the curious forms herein described.

The tubes are grouped in idmoneiform fascicles, but the tubes do not have adjacent peristomes. The spaces between the fascicles are of real tubes or aborted. They are ramified on the tubes of the fascicles primitively formed and their coalescence engenders new fascicles. At the exterior they are visible or invisible, according to the thickness of the tissue.

### REPTOCLAUSA DENTICULATA, new species

Plate 18, fig. 1

*Description.*—The zoarium creeps over shells in fronds branching at a right angle. The tubes are arranged on each side of the median crest in transverse rows. There are two tubes in each row; the peristomes are *denticulated* and nonadjacent. All the branches are surrounded by a more or less broad foliaceous expansion formed of aborted tubes.

*Measurements.*—Diameter of peristomes, 0.16 mm.; maximum diameter of branches, 1 mm.

*Affinities.*—In its zoarial simplicity this species much resembles *Idmonea alipes* Gregory, 1899, but differs in its denticulate peristomes.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Holotype.*—Cat. No. 69936, U.S.N.M.

### REPTOCLAUSA HAGENOWI Sharpe, 1854

Plate 18, figs. 2–5

1899. *Idmonea hagenowi* Gregory, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 152, pl. 8, fig. 1. (Bibliography.)

*Structure.*—We have been able to make some sections of this species. In transverse section through a fascicle the tubes are rounded, and in the vicinity of the crest they are surrounded by a strong solid epitheca. In longitudinal section the tubes are short, oblique, club-shaped; the crest is a thickened continuous epitheca.

On the fascicles the tubes are arranged in quincunx; the peristomes are orbicular and somewhat salient and their diameter is larger in the vicinity of the crest of the fascicles.

*Occurrence.*—Lower Cretaceous: Faringdon, England (Aptian); Villers-le-Lac (Doubs), France (Valangian).

*Plesiotype.*—Cat. No. 69937, U.S.N.M.

### REPTOCLAUSA MEANDRINA De Loriol, 1868

Plate 18, figs. 6–8

1868. *Reptoclausa meandrina* De Loriol, Valanginién d' Arzier, Paléontologie Suisse, Liv. 4, p. 62, pl. 6, fig. 1.

The zoarium encrusts *Terebratulas* and oyster shells. The peristomes are wider than in *Reptoclausa hagenowi* and the fascicles are arranged much more irregularly. The interfascicular tubules are often visible exteriorly. We have found beautiful specimens in our collections.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix and D'Arzier, Switzerland.

*Plesiotype.*—Cat. No. 69938, U.S.N.M.

### REPTOCLAUSA NEOCOMIENSIS D'Orbigny, 1853

1853. *Reptoclausa neocomiensis* D' ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 888, pl. 765, figs. 1, 2.

1899. *Idmonea neocomiensis* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 155. (Bibliography.)

This species is well characterized by its short fascicles arranged in quincunx.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix and Mont Salevè, Switzerland, and Villers-le-Lac (Doubs), France.

## Family TRETOCYCLOECIIDAE Canu, 1919

### Genus TRETOCYCLOECIA Canu, 1919

### TRETOCYCLOECIA (?) MULTIPOROSA, new species

Plate 16, figs. 5–8

*Description.*—The zoarium is small, cylindrical, bifurcated. The orifice is orbicular; the peristomes are thin, salient, arranged in quincunx, scattered or in annular rows. The mesopores are large, *numerous*, polygonal, irregularly placed around the orifices. The ovicell is orbicular.

*Measurements.*—Diameter of aperture, 0.08 mm.; diameter of peristome, 0.10 mm.; diameter of zoarium, 1.25 mm.; diameter of mesopores, 0.10 mm.

*Affinities.*—The mesopores seem to be parietal. Their exterior diameter is perceptibly equal to that of the peristomes. The ovicells found were broken and difficult to interpret. The tubes are cylindrical. The species differs from *Tretocycloecia densa* by its very numerous mesopores as large as the peristomes.

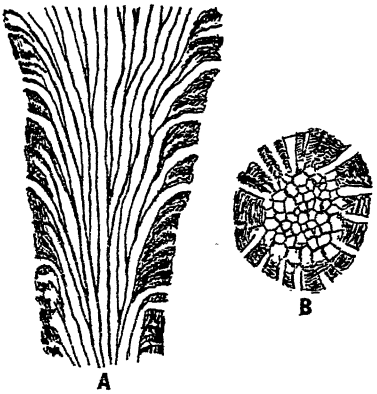


FIG. 42.—*Tretocycloecia densa*, new species. A, B. Longitudinal sections, × 16. The mesopores are almost closed by thick tissue. Lower Cretaceous (Aptian): Faringdon, England

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (rare).

*Cotypes.*—Cat. No. 69939, U.S.N.M.

### TRETOCYCLOECIA DENSA, new species

Plate 16, figs. 9–14

*Description.*—The zoarium is free, small, cylindrical, bifurcated. The orifices are orbicular; the peristomes are thin, salient, close together, sometimes adjacent, arranged in quincunx. The mesopores are little numerous, small, irregularly distributed around the apertures, short, parietal, sometimes closed by a lamella. The ovicell is orbicular, nonsalient, traversed by 15 tubes.

*Measurements.*—Diameter of orifice, 0.09 mm.; diameter of peristome, 0.11 mm.; diameter of mesopores, 0.04 mm.; diameter of zoarium, 1.25 mm.

*Structure.*—In transverse section the tubes are cylindrical or polygonal, with adjacent walls, with regular peripheral gemmation. In longitudinal section the tubes are long, cylindrical, narrowed at the base, with regular peripheral gemmation in the vicinity of the zoarial axis; they are recurved at their extremity. The mesopores are parietal, but, as their arrangement around the aperture is irregular, they are cut in sections irregularly and present the most varied forms; their walls are very thick. In tangential sections the mesopores are very small and surrounded by very thick calcareous tissues.

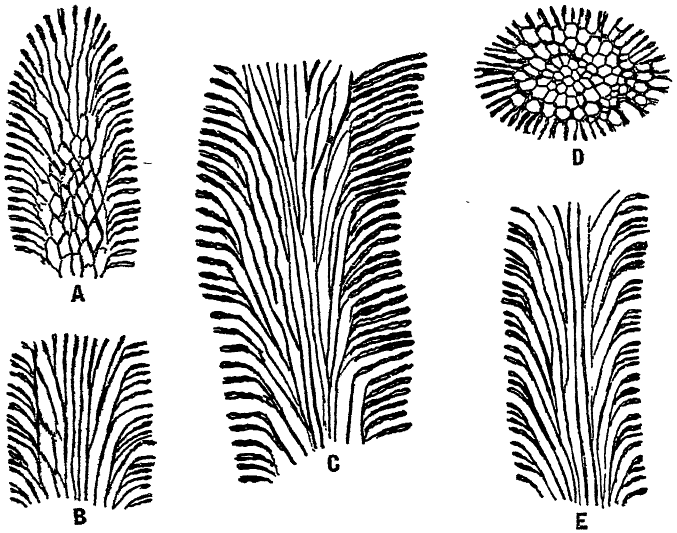


FIG. 43.—*Laterocavea dutempleana* D'Orbigny, 1853. A. Meridian section, × 16, through a growing branch, showing the lozenge-shaped areas. B. Longitudinal section, × 16, with an accessory exterior lamella at the left. C. Meridian section, × 16, showing mesopores only in the lateral faces. D. Transverse section, × 16, through a normal branch. E. Longitudinal section, × 16, illustrating the cylindrical tubes with triparietal gemmation around a central tube. Lower Cretaceous (Aptian): Faringdon, England

*Affinities.*—This species differs from *Tretocycloecia multiporosa* in its much smaller mesopores. It differs from *Heteropora keepingi* Gregory, 1909, which has a similar exterior aspect, in its much smaller zoarium, and in its smaller zooecial diameter (0.09 and not 0.15 mm.).

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England (common).

*Cotypes.*—Cat. No. 69940, U.S.N.M.

## Family ASCOSOECIIDAE Canu, 1919

### Genus LATEROCAVEA D'Orbigny, 1853

1853. *Laterocavea* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 933.

*Original diagnosis.*—"Colonie fixe par sa base, d'ou partent des ameaux tres comprimés, divisés par des dichotomisations sur le ême plan et représentant un ensemble flabelliforme dendroide. Chaque branche comprimée est pourvue, sur ses deux faces larges de *lignées* transversales espacées, composées d'une seule rangée de *ellules* tubuleuses; entre ces lignées sont de nombreux *pores intermédiaires*. Sur le côte étroit des branches sont des surfaces tres grandes, couvertes seulement de *pores opposés* épars, ou par lignes longitudinales bifurquées dans des sillons."

*Diagnosis.*—The zoarium is dichotomous and formed of compressed fronds. The tubes are oriented toward two cellular faces; they are cylindrical, with peristome; their gemmation is axial around a central tube. They are separated by parietal mesopores. The two noncellular sides are formed only of parietal mesopores. The ovicell is placed on a side with mesopores.

*Genotype.*—*Laterocavea dutempleana* D'Orbigny, 1853. Cretaceous.

### LATEROCAVEA DUTEMPLEANA D'Orbigny, 1853

Plate 15, figs. 1–6

1853. *Laterocavea dutempleana* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 933, pl. 772, figs. 7–10.

We have discovered some excellent specimens of this remarkable species, which have permitted us to study the detailed structure. In transverse section the tubes are round and grouped around a central tube. The parietal mesopores have very thick walls; they form an exterior zone, regular, enlarged laterally.

In longitudinal section the tubes are cylindrical, short, somewhat narrowed at their base. The gemmation is axial around a central tube, which ramifies at the dichotomisations. In their terminal recurved portion the tubes are separated by parietal mesopores, with thickened walls.

In meridian section the axial tubes have the lozenge-shape derived from their orientation toward the broad sides. The lateral tubes are aborted and emit only parietal mesopores much longer than the others.

In tangential section the orifices are elliptical, often adjacent laterally, and separated in the longitudinal direction by irregular groups of 4 or 5 mesopores.

We have sectioned a specimen containing on one side an exterior accessory intrazoarial lamella. It is a curious phenomenon which we have observed for the first time.

On the broad sides the peristomes are arranged irregularly on the median axis and in laterally transverse lines, an arrangement close to that observed in *Hornera.*

*Occurrence.*—Lower Cretaceous (Aptian): Grandpré (Ardennes), France; Faringdon, England (common).

*Plesiotypes.*—Cat. No. 69941, U.S.N.M.

### LATEROCAVEA INTERMEDIA, new species

Plate 13, figs. 9–17

*Description.*—The zoarium is small, cylindrical, dichotomously branched. On the principal branches the orifices are arranged laterally, although the entire anterior surface is occupied by mesopores. On the terminal branches the orifices are disposed entirely around the colony. In the cellular parts the orifices are arranged in irregular transverse lines; the peristomes are almost always adjacent and separated longitudinally by groups of four mesopores. The ovicell is globular, elliptical, large, and always placed on a side with mesopores.

*Measurements.*—Diameter of orifice, 0.08 mm.; zooecial width, 0.14 mm.; distance of orifices, 0.25 mm.; diameter of branches, 1 mm.

*Affinities.*—The arrangement of the orifices is absolutely contrary to that in *Laterocavea dutempleana* D'Orbigny, 1853, because they are lateral and not on the plane of dichotomisation. Furthermore, the small branches, bearing orifices entirely around the colony, offer the aspect of *Petalopora* Lonsdale, 1850. Complete zoaria present, therefore, all the characters intermediate, between the two genera *Laterocavea* and *Petalopora.* This species differs again from *Laterocavea dutempleana* D'Orbigny, 1853, in its rounded instead of compressed and much smaller branches.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Cotypes.*—Cat. No. 69942, U.S.N.M.

### Genus SIPHODICTYUM Lonsdale, 1849

1849. *Siphodictyum* LONSDALE, Notes on Fossil Zoophytes, Quarterly Journal Geological Society London, vol. 5. p. 94.

The ovicell is an elliptical, very convex sack, perforated by a certain number of tubes (type of *Ascosoecia*). The tubes are short, with peristome, with triparietal gemmation around a central axis. The zoarial epitheca is very thick and perforated all around the colony by small numerous vacuoles, issuing from aborted tubes and arranged at the bottom of the sulci.

*Genotype.*—*Siphodictyum gracile* Lonsdale, 1849. Cretaceous (Aptian, Albian and Campanian).

*Affinities.*—Gregory, 1899, classified this genus in the Horneridae. This is correct so far as the exterior aspect and the nature of the tubes is concerned, but the ovicell is quite different and is of the type characteristic of the Ascosoeciidae.

The genus differs for *Laterocavea* D'Orbigny, 1853, in the nature of the adventitious pores, which are vacuoles and not mesopores. In the occurrence of large noncellular areas the two genera are very close but the areas are arranged quite differently.

*Siphodictyum* differs from *Reteporidea* D'Orbigny, 1853, in the nature of the adventitious pores, which are vacuoles placed at the bottom of the sulci, and in its nonreticulate zoarium.

The physiological function of the vacuoles in recent *Hornera* is not known, and we are unable, therefore, to understand the importance of the large noncellular spaces on species of *Laterocavea* and *Siphodictyum.*

Certain branches are petaloporoid, as they have orifices entirely around the zoarium.

### SIPHODICTYUM GRACILE, Lonsdale, 1849

Plate 14, figs. 14–21

1899. *Siphodictyum gracile* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 1, p. 363, fig. 45, pl. 12, figs. 14, 15. (Bibliography.)

*Measurements.*—Diameter of orifices, 0.08 mm.; diameter of zooecia, 0.16 mm.; distance of orifices along margin, 0.40 mm.; diameter of large branches, .070 mm.

*Structure.*—The zoarium is cylindrical, dichotomously branched. The peristomes are salient, adjacent, and arranged in transverse rows interrupted in the middle, on the anterior face of the colony. They are separated in the longitudinal direction by 4 to 6 vacuoles. On the posterior face only vacuoles occur, at the base of broad sulci of little depth; the sulci are rarely longitudinal and are almost always more or less oblique. This arrangement prevents the discovery of the true nature of the pores as observed in thin sections. The dorsal is sometimes much reduced.

In longitudinal section the zoarium appears surrounded by a very thick lamellar epitheca; the tubes are short, cylindrical, with peristome, recurved at their extremity, with triparietal gemmation, and arranged around a central axis. The tubes oriented toward the frontal are complete and separated in the recurved portions by the epitheca perforated by vacuoles; the tubes oriented toward the frontal dorsal are aborted and engender the vacuoles of the noncellular face.

Our longitudinal sections do not correspond exactly with those of Gregory, 1899 (p. 364), which seem to show parietal mesopores (=maculae). The sections of Lonsdale are incomplete.

The meridian section confirms the longitudinal section, but the tubes are symmetrically arranged on each side of the central axis. Moreover, diaphragms appear sometimes.

In transverse sections the zoarial epitheca is thick, lamellar, perforated by irregularly scattered vacuoles; the tubes here are almost equal and polygonal.

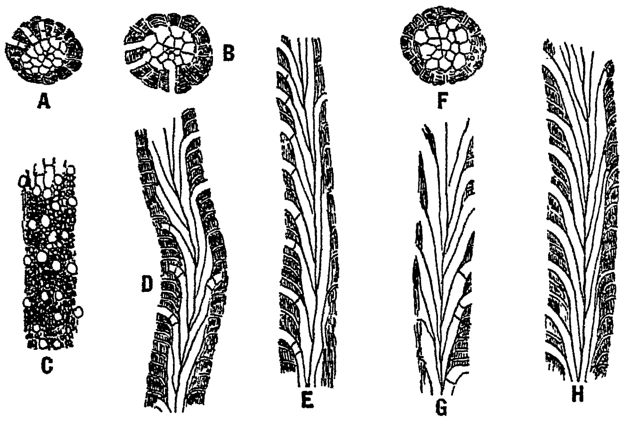


FIG. 44.—Genus *Siphodictyum* Lonsdale, 1849. A–E. *Siphodictyum irregulare*, new species. A. Transverse section, × 16, showing the polygonal tubes. B. Another transverse section, × 16, exhibiting the central axis. C. Tangential section, × 16, illustrating the arrangement of the vacuoles around the orifices D. Longitudinal section, × 16. The vacuoles perforate the epitheca all around the zoarium. E. Longitudinal section, × 16, showing the cylindrical tubes and the vacuoles perforating the epitheca. Lower Cretaceous (Aptian): Faringdon, England. F–H. *Siphodictyum gracile* Lonsdale, 1879. F. Transverse section, × 16. G. Meridian section, × 16. H. Longitudinal section, × 16, with the vacuoles perforating the thick epitheca. Lower Cretaceous (Aptian): Faringdon, England

In these various sections the zoarial pores appear, therefore, as the extremities of small tubes perforating the zoarial epitheca; these are vacuoles, as in the genus *Hornera*. Moreover, the general aspect of the species is also that of *Hornera*, although the ovicell is decidedly different, being that of the Ascosoeciidae.

*Affinities*.—This species differs from *Siphodictyum irregulare* in the salient peristomes arranged in transverse rows and more numerous on the cellular face; finally, branches formed entirely of vacuoles have never been observed.

*Occurrence*.—Lower Cretaceous (Aptian): Faringdon, Folkestone, etc., England.

*Plesiotypes*.—Cat. No. 69943, U.S.N.M.

### SIPHODICTYUM IRREGULARE, new species

Plate 14, figs. 1–11

*Description.*—The zoarium is cylindrical, slender, dichotomously branched. On the cellular face the orifices are arranged in irregular quincunx or in transverse lines interrupted in the middle; the peristomes are salient, thick, adjacent, or scattered; they are separated by groups of 2 to 4 vacuoles. On the dorsal face the vacuoles occur at the base of sulci of little depth, arranged longitudinally and obliquely. At the extremity of the branches the peristomes occur entirely around the colony. The cellular groups are separated by noncellular spaces showing only vacuoles. The ovicell is a large, very convex sack placed in the noncellular portion of the zoarium.

*Measurements.*—Diameter of orifice, 0.08 mm.; zooecial diameter, 0.12 mm.; distance of orifices, 0.28–0.32 mm.; diameter of largest branches, 0.65 mm.

*Structure.*—The longitudinal section of the cellular branches shows on the frontal a thick peripheral epitheca perforated by vacuoles, short cylindrical tubes with triparietal gemmation around a central axis, and dorsal tubes analogous but aborted and engendering the vacuoles.

The longitudinal section of the noncellular branches show identical characters, but all the tubes are aborted and engender numerous vacuoles.

The transverse section shows a very thick epitheca perforated by vacuoles, by complete tubes, or by incomplete tubes.

The tangential section of the cellular face shows the orbicular orifices and a variable number of small vacuoles very irregularly arranged and immersed in a thick epitheca. Irregular veinules indicate the presence of the sulci. The tangential section of the noncellular portions exhibit very small vacuoles arranged in quincunx and immersed in a thick epitheca in which the veinules are indicated by the darker portions.

This species has afforded sections closer to those of Gregory, 1899 (p. 364); but the walls of the adventitious tubes are much thicker and seem to indicate vacuoles rather than mesopores.

The orifices are arranged in transverse rows, interrupted or in quincunx. On the same zoarium there are large cellular spaces with peristomes on a single side, but they alternate with the large noncellular spaces. At the extremity of the branches the orifices are disposed entirely around the colony. The lateral dichotomisations are always very short.

*Affinities.*—This species differs from *Siphodictyum gracile* Lonsdale, 1849, in its more slender branches showing only 3 or 4 longitudinal series of tubes and in the presence of noncellular zoarial portions.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England.

*Cotypes.*—Cat. No. 69944, U.S.N.M.

### Genus ZONOPORA D'Orbigny, 1854

#### ZONOPORA COMPRESSA, new species

Plate 15, figs. 15–17; Plate 31, fig. 1

*Description.*—The zoarium is free, dichotomous; the fronds are much *compressed.* The peristomes are small, thin, nonsalient, arranged in irregular quincunx, grouped in zones separated by wide areas of mesopores and surrounded by some mesopores.

*Measurements.*—Diameter of orifice, 0.10 mm.; diameter of mesopores, 0.04–0.06 mm.; distance of peristomes, 0.24–0.26 mm.; separation of peristomes, 0.36–0.40 mm.

*Structure.*—The sectioned specimens were accidentally hollow, giving the sections a strange aspect which might make them appear to belong to another genus. However, we have found the usual structure seen in sections of *Zonopora.*

The longitudinal section in *Zonopora* is very difficult to interpret because of the great multiplicity of tubes and of their vesicular walls. Those which we have made are not clear enough to be reproduced, but we have been able to observe the essential characters.

*Affinities.*—This is the only species of *Zonopora* in which the fronds are compressed.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

*Cotype.*—Cat. No. 69945, U.S.N.M.

#### ZONOPORA ARBOREA Koch and Dunker, 1837

Plate 15, figs. 7–10; Plate 31, figs. 2–4

1909. *Multizonopora arborea* GREGORY, Catalogue Cretaceous Bryozoa in the British Museum, vol. 2, p. 220, figs. 57–61. (Bibliography and geologic distribution.)

*Measurements.*—Diameter of the orifices, 0.08 mm.; diameter of the mesopores, 0.04 mm.

*Structure.*—The specimens from Sainte-Croix are large and rough, but they are not multilamellar. The cellular zones are very irregular and quite variable in their extent. The determination by the exterior features alone is always difficult if the observer is not acquainted with all the known variations in such fossils.

The illustrated sections of this species are those of Pergens, 1889, and of Gregory, 1909. Our specimens from Sainte-Croix were silicified and could not be sectioned, but a well-preserved example from Berklingen has afforded some interesting results. In the transverse section here figured the tubes are polygonal, with a rounded center, cylindrical, of uniform diameter. The recurved parts of the tubes and the mesopores have very thick vesicular walls in confirmation of Gregory's figure 61. Gemmation takes place especially in the vicinity of the central axis.

The tangential section shows small scattered mesopores embedded in the zoarial epitheca.

*Occurrence.*—Lower Cretaceous: Sainte-Croix, Switzerland (Valangian); Berklingen, Germany.

*Plesiotypes.*—Cat. No. 69946, U.S.N.M.

### Genus SPARSICAVEA D'Orbigny ,1853

#### SPARSICAVEA IRREGULARIS D'Orbigny, 1853

Plate 15, figs. 11–14.

1853. *Sparsicavea irregularis* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 949, pl. 617, figs. 5–7.

*Measurements.*—Diameter of aperture 0.07–0.08 mm.; diameter of peristome, 0.12 mm.; diameter of zoarium, 1–2 mm.

*Structure.*—Our determination is exact, as our specimens are rigorously analogous to those of D'Orbigny. His figure is not altogether exact, as admitted by himself, the unequal spacing of the peristomes not being visible. Our photographs show this feature very well. Mesopores are rather numerous; they are infundibuliform at their extremity and appear consequently smaller in tangential section. The peristome is salient and thick.

The longitudinal section shows the usual feature of *Sparsicavea*, namely club-shaped tubes, peripheral and axial gemmation, parietal mesopores (=maculae of Gregory), with very thick walls. In transverse section the thickening of the walls of the mesopores forms a regular epithecal zone.

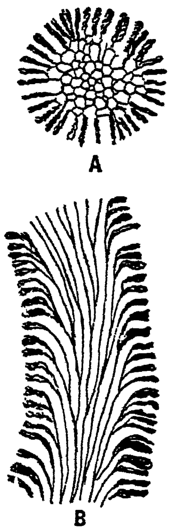


FIG. 45.—*Sparsicavea irregularis* D'Orbigny, 1851. A. Transverse section, × 16. B. Longitudinal section, × 16. Lower Cretaceous (Aptian): Faringdon, England

All the known ovicelled species with *Sparsicavea* characters are referred to the genus *Parascosoecia*, but until the ovicell of the present one is known we believe it best to refer it to the older name.

*Occurrence.*—Lower Cretaceous (Aptian): Faringdon, England; Machoremenil (Ardennes), France.

*Plesiotypes.*—Cat. No. 69947, U.S.N.M.

## Family CORYMBOPORIDAE Smitt, 1866

### Genus CORYMBOPORA Michelin, 1845

### CORYMBOPORA NEOCOMIENSIS D'Orbigny, 1853

Plate 8, figs. 13–16

1853. *Corymbopora neocomiensis* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p, 670, pl. 783, figs. 20–23.

1909. *Fasciculipora neocomiensis* GREGORY, Catalogue of the Cretaceous Bryozoa in the British Museum, vol. 2, p. 37. (Bibliography.)

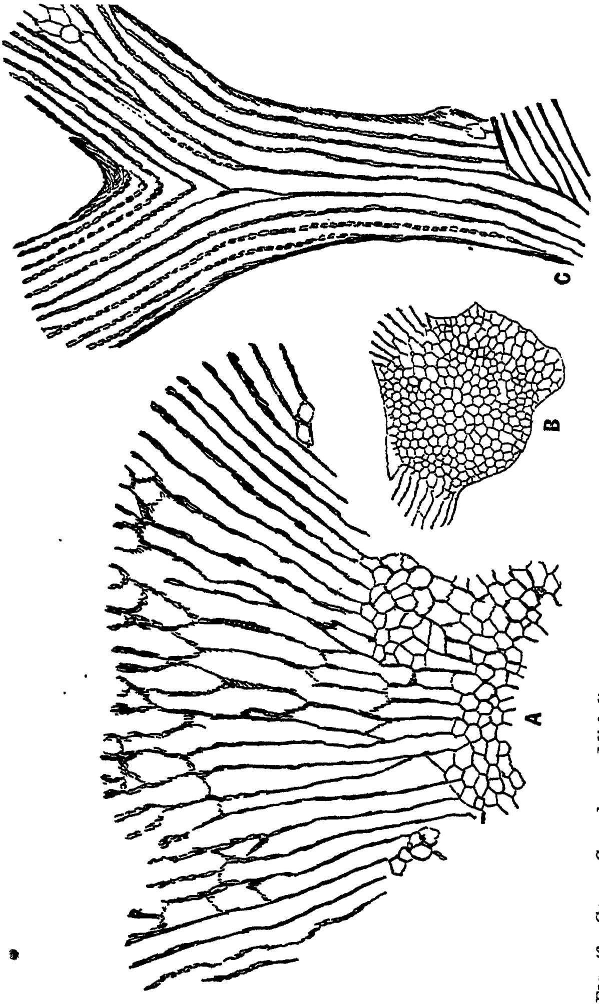


FIG. 46.—Genus *Corymbopora* Michelin, 1845. A. *Corymbopora ? cupula* D'Orbigny, 1853. Meridian section, × 16. Cretaceous (Cenomanian) Le Mans, France. B, C. *Corymbopora neocomiensis* D'Orbigny, 1853. B. Transverse section, × 8. The tubes are polygonal with walls adjacent and larger at the zoarial center. C. Longitudinal section, × 16, in a branch with three pinnules. The walls of the tubes are moniliform. Cretaceous (Valangian); Sainte-Croix, Switzerland

*Structure.*—The branches figured by D'Orbigny are of young specimens; as they are thin, they appear long. The older branches formed of a greater number of tubes have a broader, thicker aspect; the zoarium appears like a circular stem bearing short pinnules in all directions. The base is a circular disk, little expanded.

The longitudinal section is that characteristic of the Corymboporidae as Canu has figured in 1919. The walls of the tubes are moniliform. The gemmation is incomprehensible and the nature of the pores remains still doubtful. Gregory's hypothesis is not clear. "The pores seem to be due to the nearly complete filling of the aperture of the dead zoaria by epizoarial material."

In transverse section the tubes are polygonal, with adjacent walls; they are larger at the zoarial center.

*Occurrence.*—Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

*Plesiotypes.*—Cat. No. 69948, U.S.N.M.

### CORYMBOPORA (?) CUPULA D'Orbigny, 1853

Plate 8, figs. 1–7

1853. *Reptomulticava cupula* D'ORBIGNY, Paléontologie française, Terrain Crétacé, vol. 5, p. 1037, pl. 792, figs. 6–11.

Our determination is possibly incorrect, for D'Orbigny's figures do not indicate smaller tubes at the center of the zoarium nor colonies so thick. We maintain our determination, however, because specimens of D'Orbigny's species as figured by him have never been rediscovered at Le Mans.

Our specimens are capitate, simple or agglomerate. The ovicel is that of the Corymboporidae, absolutely analogous with that o the genotype figured by Canu. Exteriorily the zoarium appears to be formed of superposed lamellae in which the tubes are much smaller at the center and on the margin. This is an illusion resulting from the special mode of gemmation in *Corymbopora.* Thin sections confirm this observation.

*Occurrence.*—Cretaceous (Cenomanian): Le Mans (Sarthe), France.

*Plesiotypes.*—Cat. No. 69949, U.S.N.M.

## EXPLANATION OF PLATES

### PLATE 1

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| | 4. Young slender branch, ×12. | |
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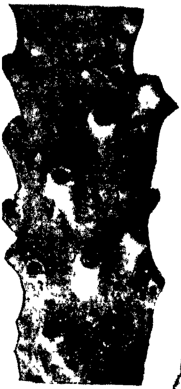
| | 12. Ovicelled portion of the surface, ×12. | |
| | Lower Cretaceous (Aptian): Faringdon, England. | |



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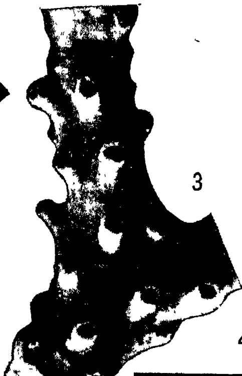

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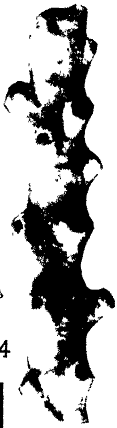

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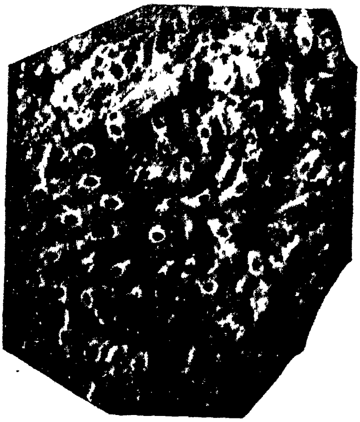

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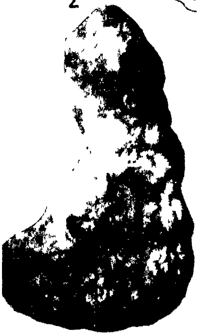

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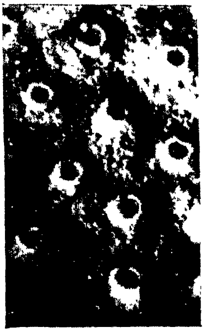

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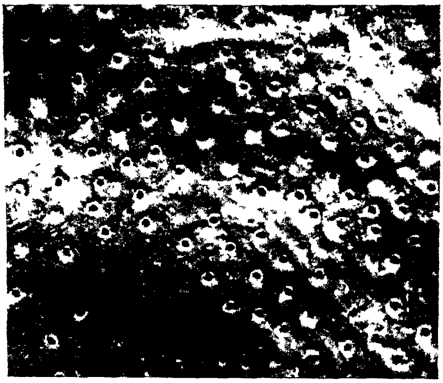

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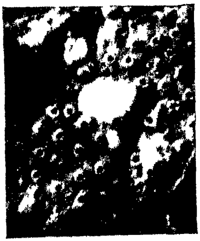

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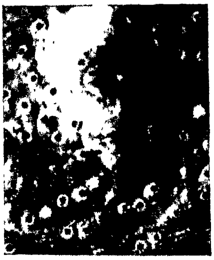

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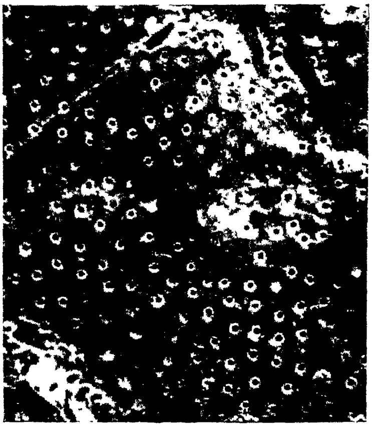

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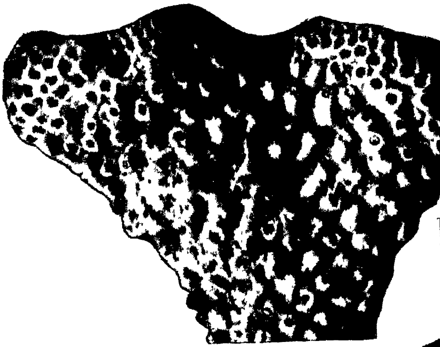
LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 94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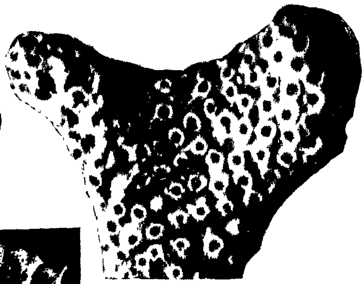
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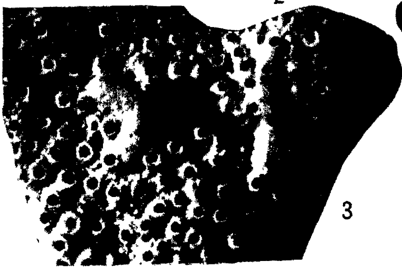
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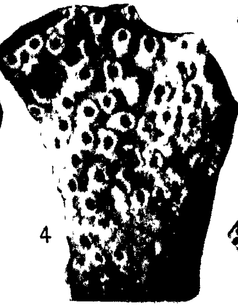
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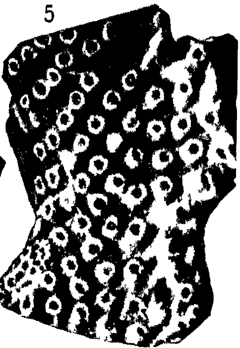
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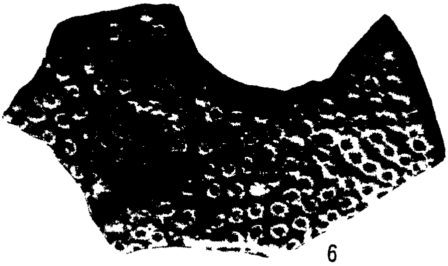
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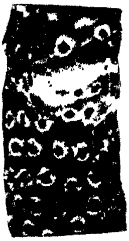
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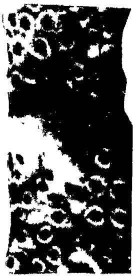
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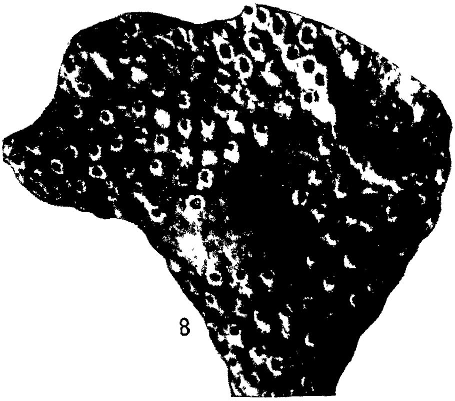
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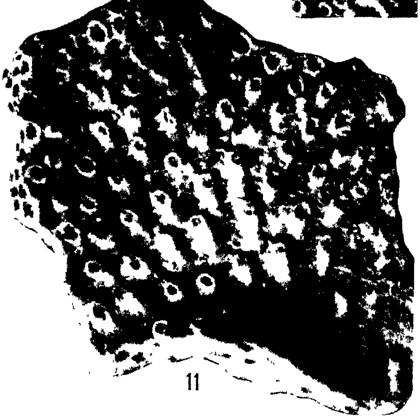
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 95

## PLATE 2

Page

FIGS. 1–7. *Cardioecia neocomiensis* D'Orbigny, 1853 ---------- 40

1. Fragments, natural size.
2. Portion of a zoarium, ×12. Many of the tubes are visible. The zone of growth is short and thick.
3. A bifurcated, ovicelled frond, ×12. The ovicells are complete and symmetrical. The zone of growth is short and thick.
4. Fragment, ×12, in which the peristomes are little salient and the ovicell little regular.
5. Zoarium, ×12, with peristomes almost adjacent.
6. Ovicelled zoarial fragment, ×12. The peristomes are little salient. The ovicells are little regular and little symmetrical.
7. Frond with salient peristomes, ×12. The tubes are distinct only in the inferior part.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 8. *Cardioecia neocomiensis*, var. *parvula*, new variety ---------- 42

Ovicelled specimen, ×12, illustrating the small peristomes.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 9, 10. *Cardioecia neocomiensis*, var. *entalophoroides*, new variety --- 42

Two ovicelled specimens, ×12. The tubes are in quincunx or in transverse rows.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 11. *Trigonoecia neocomiensis* D'Orbigny, 1853 ---------- 39

A frond, ×12, on which the wrinkles are quite visible.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 3

Page

FIGS. 1–4. *Cardioecia verticellata*, new species ........................ 42

1. Zoarial fragments, natural size.
2. Branch, ×12, in which the peristomes are worn.
3. Cylindrical zoarium, ×12, with the zone of growth preserved.
4. Compressed zoarium with its ovicell, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5–8. *Cardioecia hyselyi* De Loriol, 1869 ........................ 43

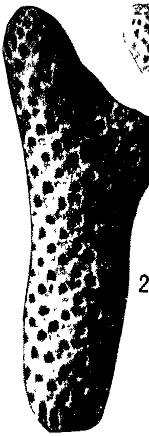
5. Specimen, natural size and ×12, with tubes visible.
6. Foliaceous specimen, ×12, with its zone of growth. The tubes are not visible.
7. Surface, ×25. The tubes are convex and visible.
8. Portion of ovicelled specimen, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 9–15. *Cardioecia faringdonensis* Canu and Bassler, 1922 .......... 44

9. Fragments, natural size.
10. Young cylindrical branch, ×12, with zone of growth and in which the tubes are arranged in the Peripora form.
11. Young cylindrical branch, ×12.
12. Ovicelled specimen, with narrow base, ×6.
13. Compressed branch, ×12, with a large zone of growth.
14. Large branch, ×12, much compressed, with the tubes arranged transversely.
15. Portion of surface of compressed zoarium, ×25.

Lower Cretaceous (Aptian): Faringdon, England.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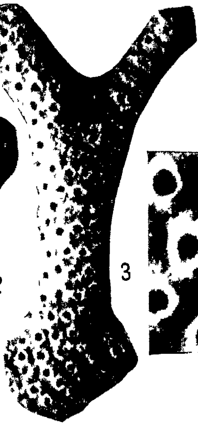
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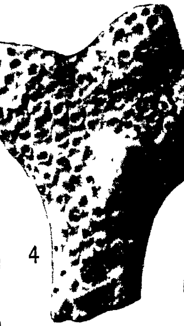
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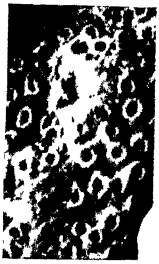
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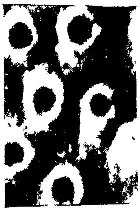
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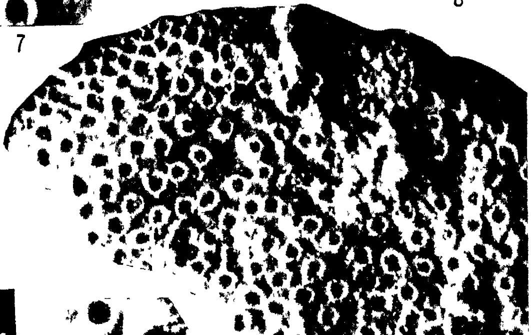
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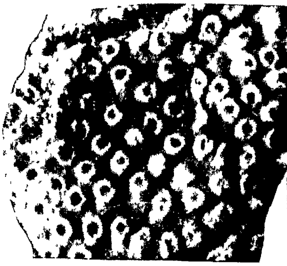
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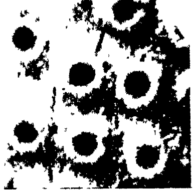
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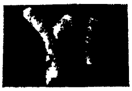
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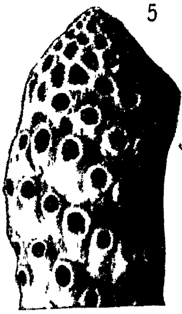
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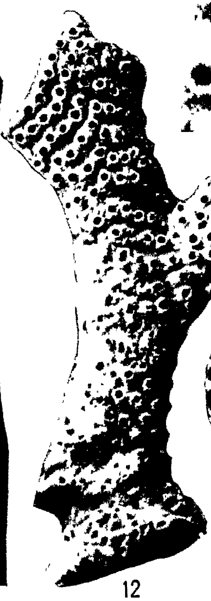
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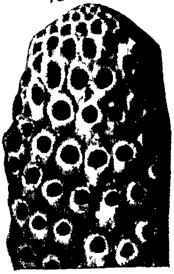
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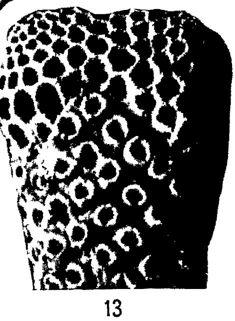
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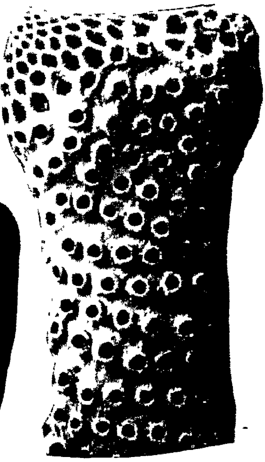
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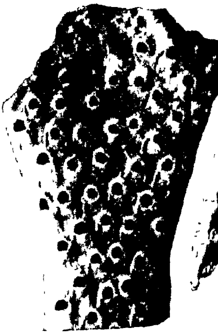
LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 96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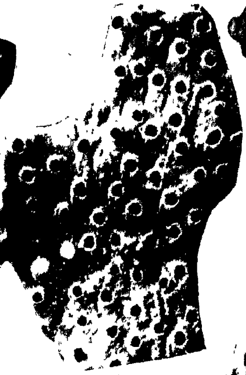
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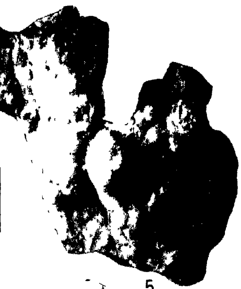
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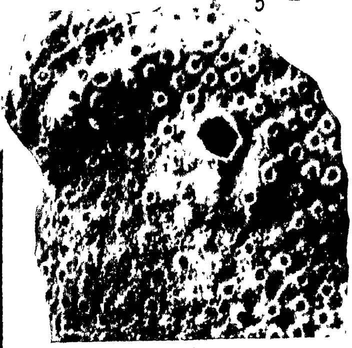
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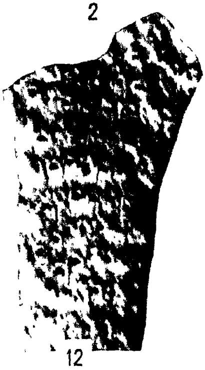
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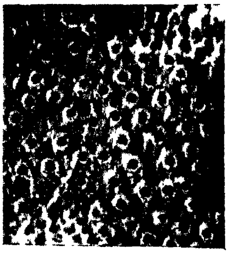
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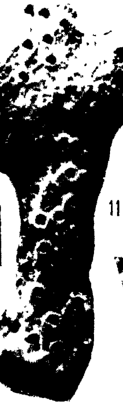
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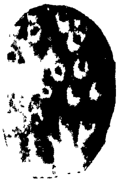
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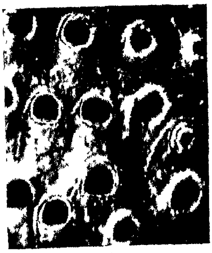
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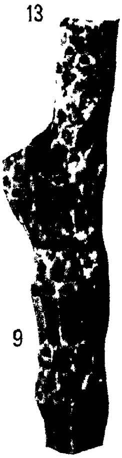
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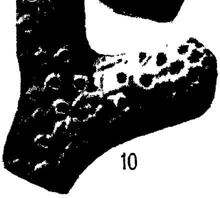
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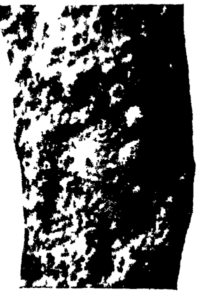
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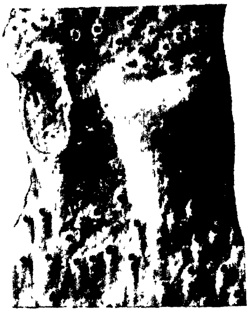
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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 97

# PLATE 4

Page

FIGS. 1–4. *Nematifera reticulata* D'Orbigny, 1853 ---------- 45

1. Fragments, natural size.
2. Bifurcated branch, not reticulated, ×12.
3. Portion of reticulated specimen, ×12.
4. Same specimen as 3, ×25, showing a regenerated tube.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5–7. *Nematifera incrustans*, new species ---------- 46

5. Zoarium, natural size.
6. Portion of surface, ×12.
7. Fragment of the zoarial surface, ×12, showing the ovicell (broken) and the short zone of growth.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 8–11. *Nematifera reticuloides*, new species ---------- 47

8. Fragments, natural size.
9. Slightly worn specimen, ×12, on which the peristomes are arranged in close transverse groups (*Peripora*).
10. Extremity of a young bifurcated branch, ×12, showing the zone of growth.
11. Fragment of a reticulated specimen, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 12. *Nematifera acuta* D'Orbigny, 1853 ---------- 46

Fragment, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 13–15. *Trigonoecia tubulosa* D'Orbigny, 1853 ---------- 37

13. Zoaria, natural size.
14. Ovicelled specimen, ×12. The oeciostome is minute but long and salient.
15. Specimen, ×12, showing two large ovicells.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 16. *Diaperoecia simplex*, new species ---------- 50

The ovicelled type specimen, ×12.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 5

Page

FIGS. 1, 2. *Cardioecia pauper*, new species -------------------------- 44

1. Ovicelled branch, ×12, showing side on which peristomes are arranged in quincunx.
2. Opposite side of same specimen, ×12, exhibiting ovicell, and peristomes arranged in transverse rows.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 3–5. *Notoplagioecia faringdonensis* Canu and Bassler, 1922 -------- 48

3. Zoarial fragments, natural size.
4 Cylindrical branch, ×12, showing the irregular arrangement of the peristomes and the conical zone of growth.
5. Example with ovicell (broken), ×12.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 6–14. *Cea granulata*, new species ------------------------------ 49

6. Zoarial fragments, natural size.

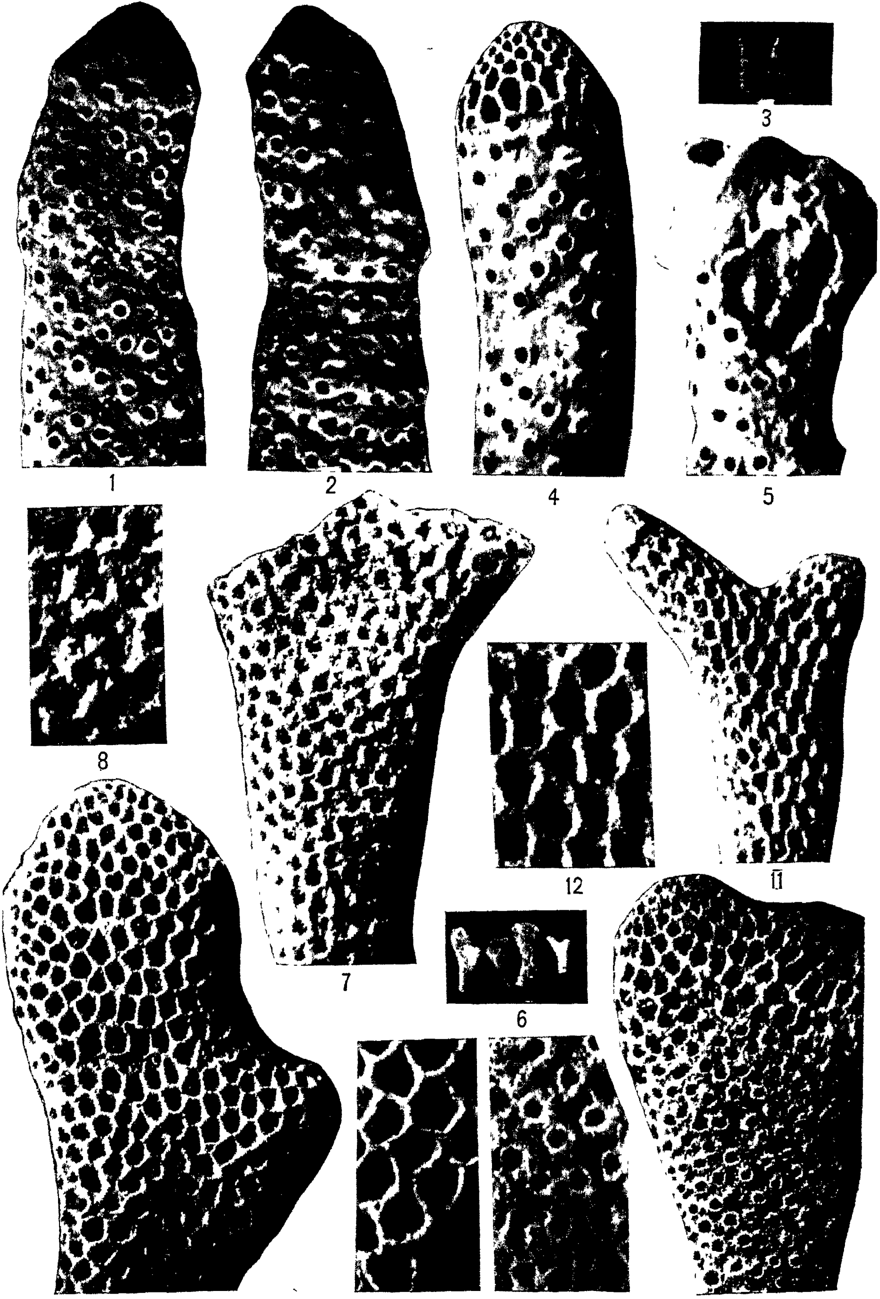
7, 8. Branch, ×12 and ×25, on which the granulated tubes are visible exteriorily.

9, 10. The most frequent aspect of the branches, ×12 and ×25.

11, 12. Branches, ×12 and ×25, showing the small, elongated orifices.

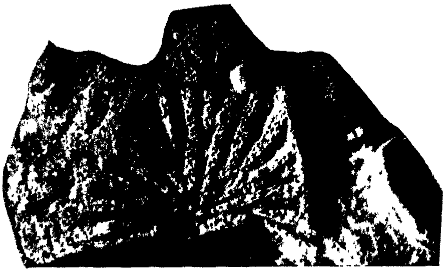
13, 14. Branch, ×12 and ×25, with granulated facettes and peristomes.

Lower Cretaceous (Aptian): Faringdon, England.



LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 98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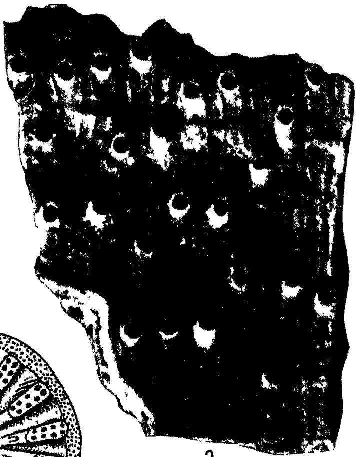
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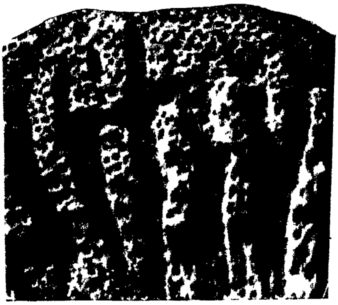
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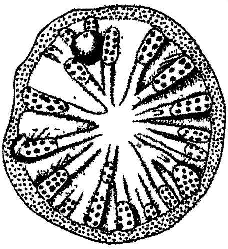
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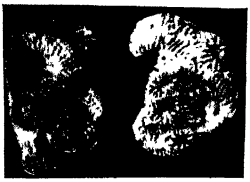
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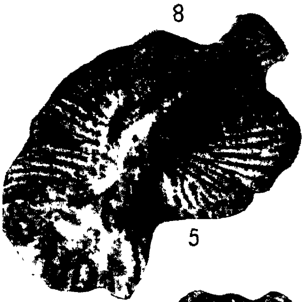
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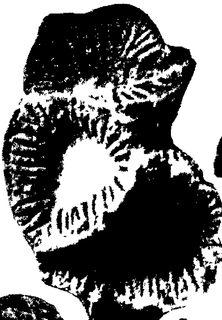
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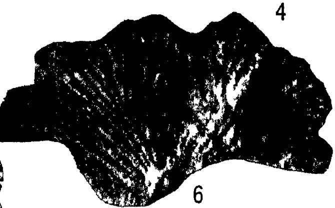
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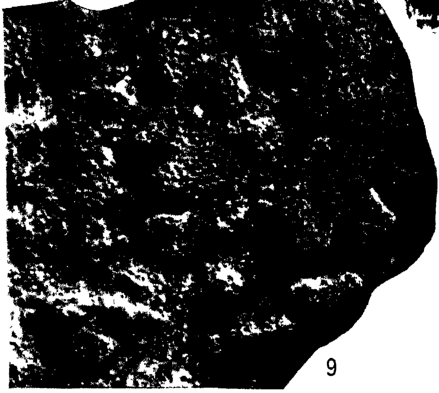
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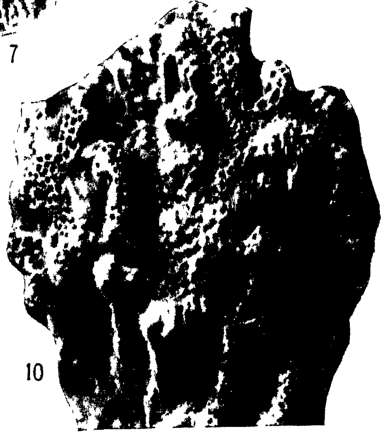
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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 99

## PLATE 6

Page

FIGS. 1, 2. *Actinopora stellata* Koch and Dunker, 1837 ..... 57
  1. Young berenicoid zoaria, ×6.
  2. Entire ovicelled zoarium, ×6. (After sketch by Waters.)
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 3. *Mesenteripora marginata* D'Orbigny, 1853 ..... 48
  Fragment, ×12.
  Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 4–8. *Multitubigera campicheana* D'Orbigny, 1853 ..... 58
  4. Two zoaria, natural size.
  5, 6, 7. Base, side and upper surface, ×2, of same zoarium.
  8. Portion of the zoarium, ×12, showing the ovicell.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 9. *Multifascigera campicheana* D'Orbigny, 1853 ..... 60
  Zoarium, ×6, formed (on the right) by two discoidal subcolonies in the *Actinopora* stage and (on the left) by a subcolony in the *Lopholepis* growth form.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 10. *Radiofascigera ramosa* D'Orbigny, 1853 ..... 60
  Ovicelled specimen, ×12, with irregular subcolonies.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 7

Page

FIGS. 1, 2. *Fasciculipora flabellata* D'Orbigny, 1853 .................. 51

1. Lateral view of a specimen, ×6, with little expanded base.
2. Zoarium, ×6, viewed from above, showing the orifices of the tubes at the extremity of the fronds.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 3, 4. *Plethopora aptensis*, new species .................. 53

3. Zoaria, natural size and enlarged.
4. Bifurcated zoarial fragment, ×12.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 5–7. *Retenoa campicheana* D'Orbigny, 1853 .................. 56

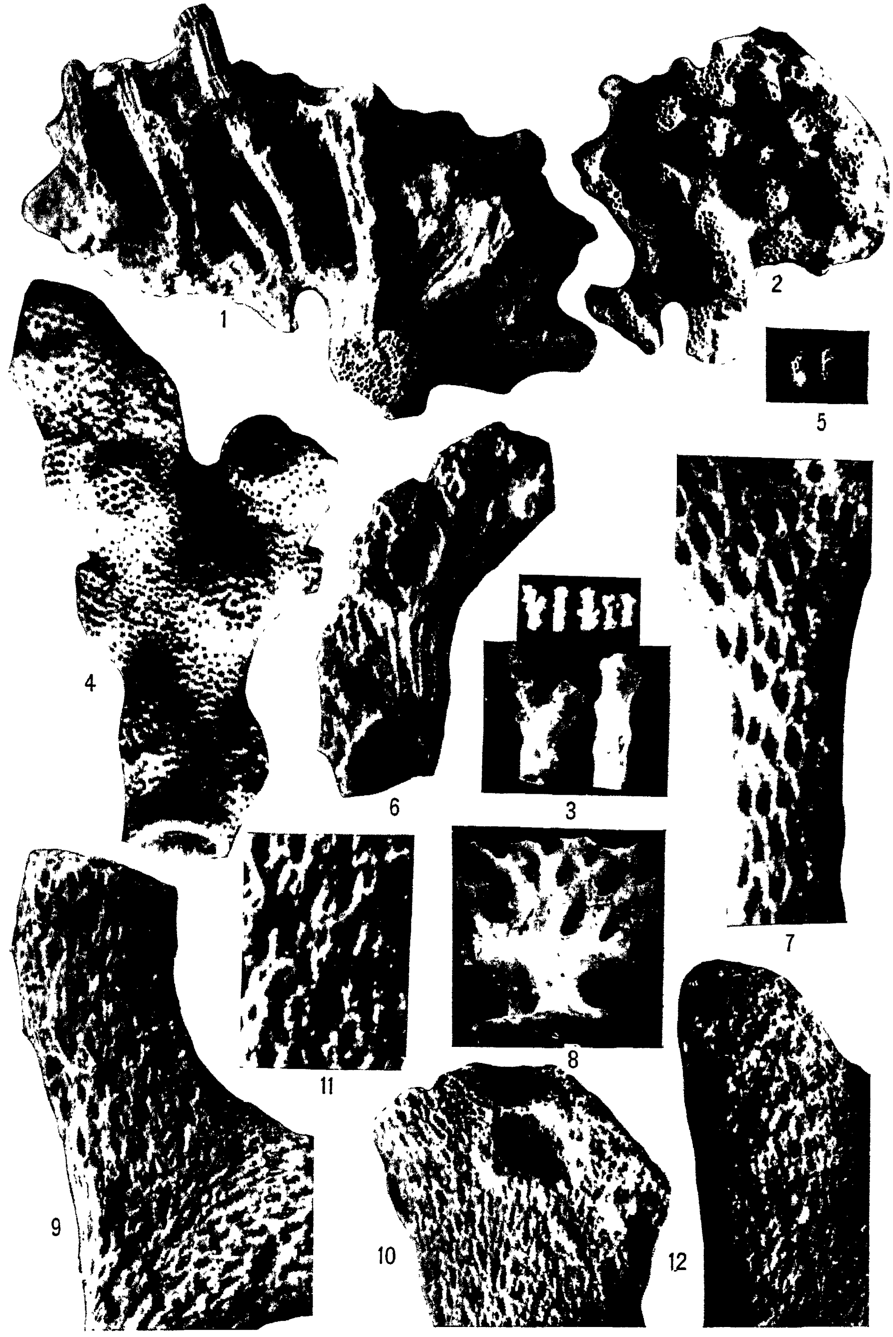
5. Fragments, natural size.
6. Posterior noncellular (dorsal) face of a branch showing an ovicell below a bifurcation, ×12.
7. Cellular (anterior) face of a bifurcated branch, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 8–12. *Chartecytis compressa*, new species .................. 55

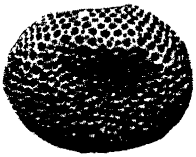
8. Zoarium, natural size.
9. Bifurcated zoarial fragment, ×12. The orifices of the tubes are lozenge-shaped slits.
10. Compressed zoarial with trace of ovicell, ×12.
11. Surface of same specimen, ×25.
12. Extremity of a branch showing the conical zone of growth.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.



LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 100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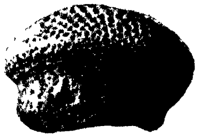
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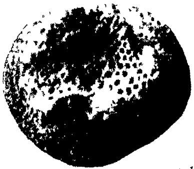
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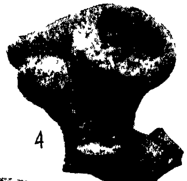
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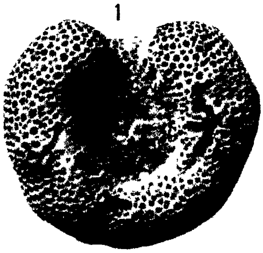
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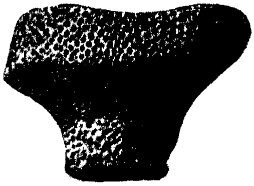
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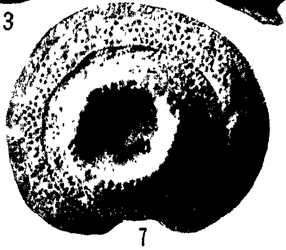
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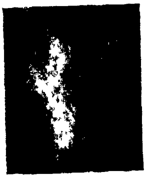
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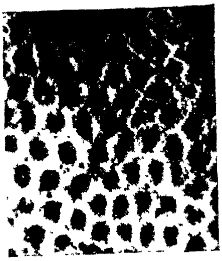
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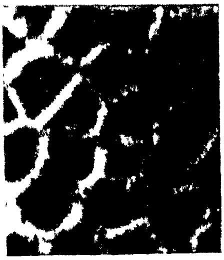
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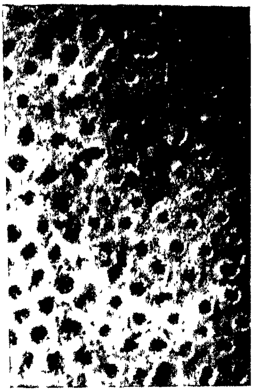
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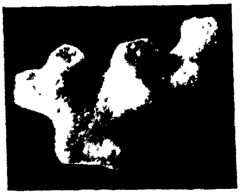
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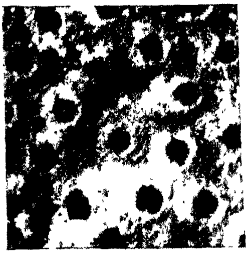
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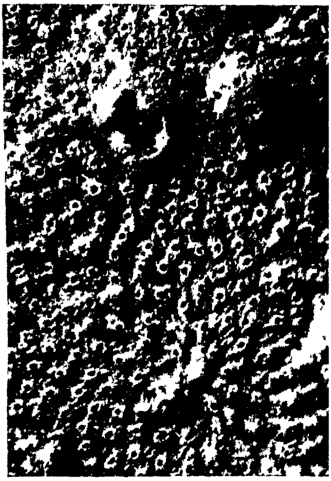
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 101

## PLATE 8

Page

FIGS. 1–7. *Cerymbopora cupula* D'Orbigny, 1853 ---------- 93

1–3. A zoarium with broad base, ×6, showing superior (1), lateral (2), and inferior sides (3).

4. Zoarium, ×3, formed of several agglomerated subcolonies.

5–7. An ovicelled zoarium with narrow base, ×6, exhibiting upper (5), lateral (6), and lower sides (7).

Cretaceous (Cenomanian): Le Mans, France.

FIGS. 8–12. *Ceriocava ingens*, new species ---------- 70

8. Zoarium, natural size.

9, 10. Portion of a large zoarium, ×12 and ×25, where the tubes have preserved their facettes.

11, 12. Portion, ×12 and ×25, in which the facettes are wanting.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 13–16. *Corymbopora neocomiensis* D'Orbigny, 1853 ---------- 92

13, 14, 15. Zoaria, natural size and enlarged.

16. Base of two zoaria enlarged; the base is a little expanded adherent disk.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 17. *Diaperoecia orbifera*, new species ---------- 51

An ovicelled zoarium, ×12.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 9

Page

FIGS. 1–10. *Ceriocava multilamellosa*, new species ........................ 68

1. Zoarial fragments, natural size.
2. An example, ×12, on which a lamella with facettes covers a portion without facettes.

3, 4. Young branch, ×12 and ×25, showing the round median orifice in the hexagonal facette.

5, 6. Branch, ×12 and ×25, on which the tubes with facettes alternate with the others.

7, 8. Fragment, ×12 and ×25, with facettes, showing the zone of growth of a second lamella.

9, 10. Branch without facettes, ×12 and ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 11–13. *Ceriocava junctata*, new species ........................ 67

11. Zoaria, natural size.

12, 13. Portion of a hollow unilamellar zoraium without facettes, ×12 and ×25.

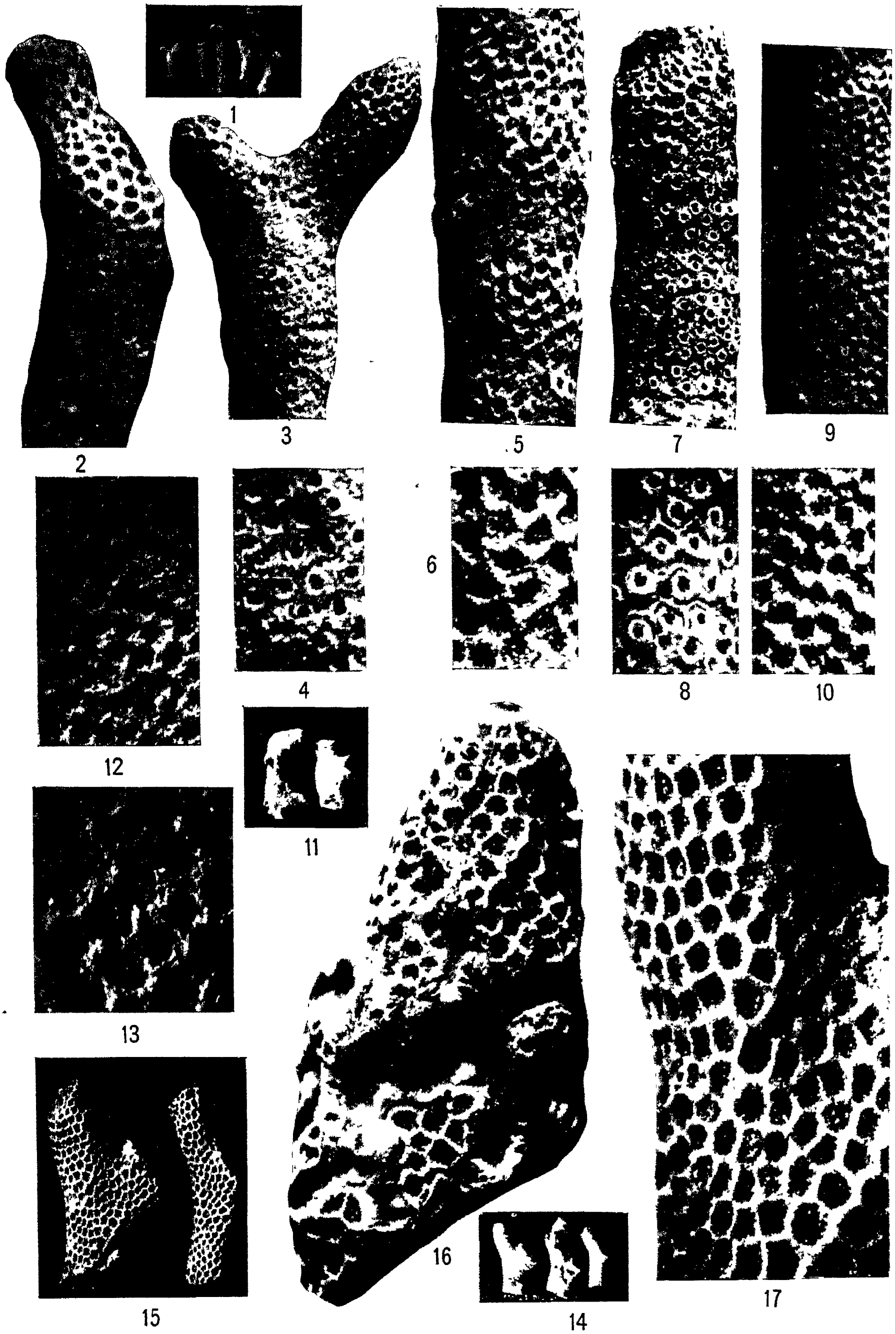
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 14–17. *Ceriocava grandipora*, new species ........................ 67

14, 15. Fragments, natural size and ×3. The base is orbicular and the extremity of the branches is conical.

16. Ovicelled specimen, ×12.
17. Normal specimen without ovicells, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.



LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

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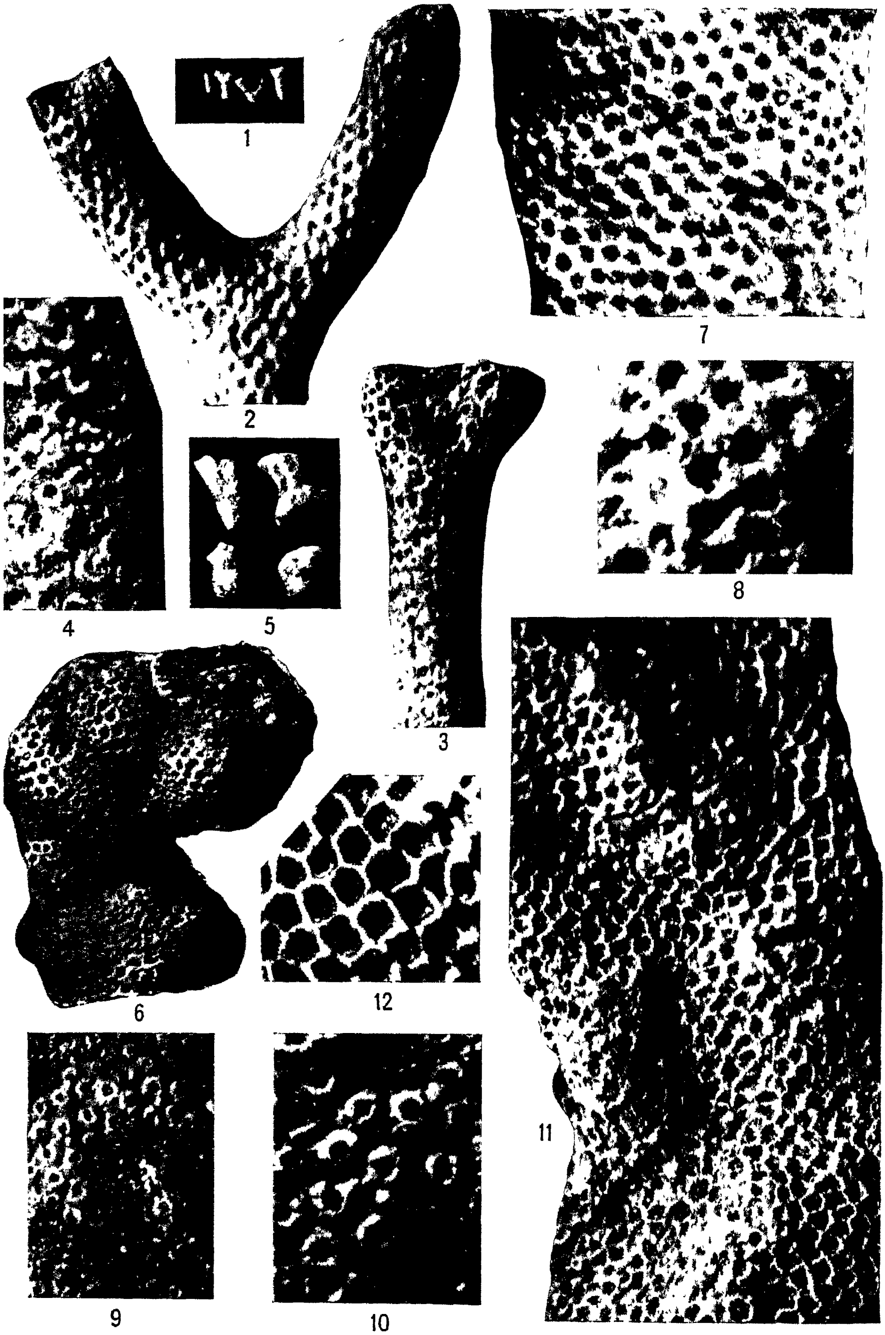


LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 103

## PLATE 10

| | Page |
|---|---|
| FIGS. 1–4. *Ceriocava tenuirama*, new species | 70 |

1. Fragments of zoarium, natural size.
2. Specimen, ×12, showing the habitual aspect.

3, 4. Example, ×12 and ×25, showing tubes with facettes and an orbicular orifice.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

| | |
|---|---|
| FIGS. 5–12. *Diplocava incondita*, new species | 71 |

5. Fragments, natural size.
6. Specimen, ×6, showing normal aspect. The groups of large tubes are surrounded by small tubes with facettes.

7, 8. Surface of arborescent zoarial fragment, ×12 and ×25, with monomorphic tubes.

9, 10. Bilamellar zoarial fragment, ×12 and ×25, showing tubes with facettes.

11. Ovicelled lamellar zoarium, ×12. The parts with large orifice are little visible. The ovicell is star-shaped with four branches.
12. Group of large zooecia without facettes, ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 11

Page

FIGS. 1–5. *Diplocava inordinata*, new species ........................ 73

1. Zoarial fragments, natural size and base of a young zoarium, ×3.
2. Fragment with small tubes, ×12.
3. Portion of zoarium with large tubes, ×12.
4. Fragment with both large and small tubes, ×12.
5. Example containing tubes with their facettes, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 6–8. *Diplocava orbiculifera*, new species........................ 73

6. The ramose zoarium, natural size.

7, 8. Zoarial surface ×12 and ×25, showing the orbicular arrangement of the groups of large tubes.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 9, 11. *Diplocava globulosa*, new species ........................ 74

9. The small massive zoarium, natural size.

11, 10. Portion of the zoarial surface, ×12 and ×25, showing the two kinds of tubes.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 12, 13. *Meliceritites semiclausa* Gregory, 1899 .................. 66

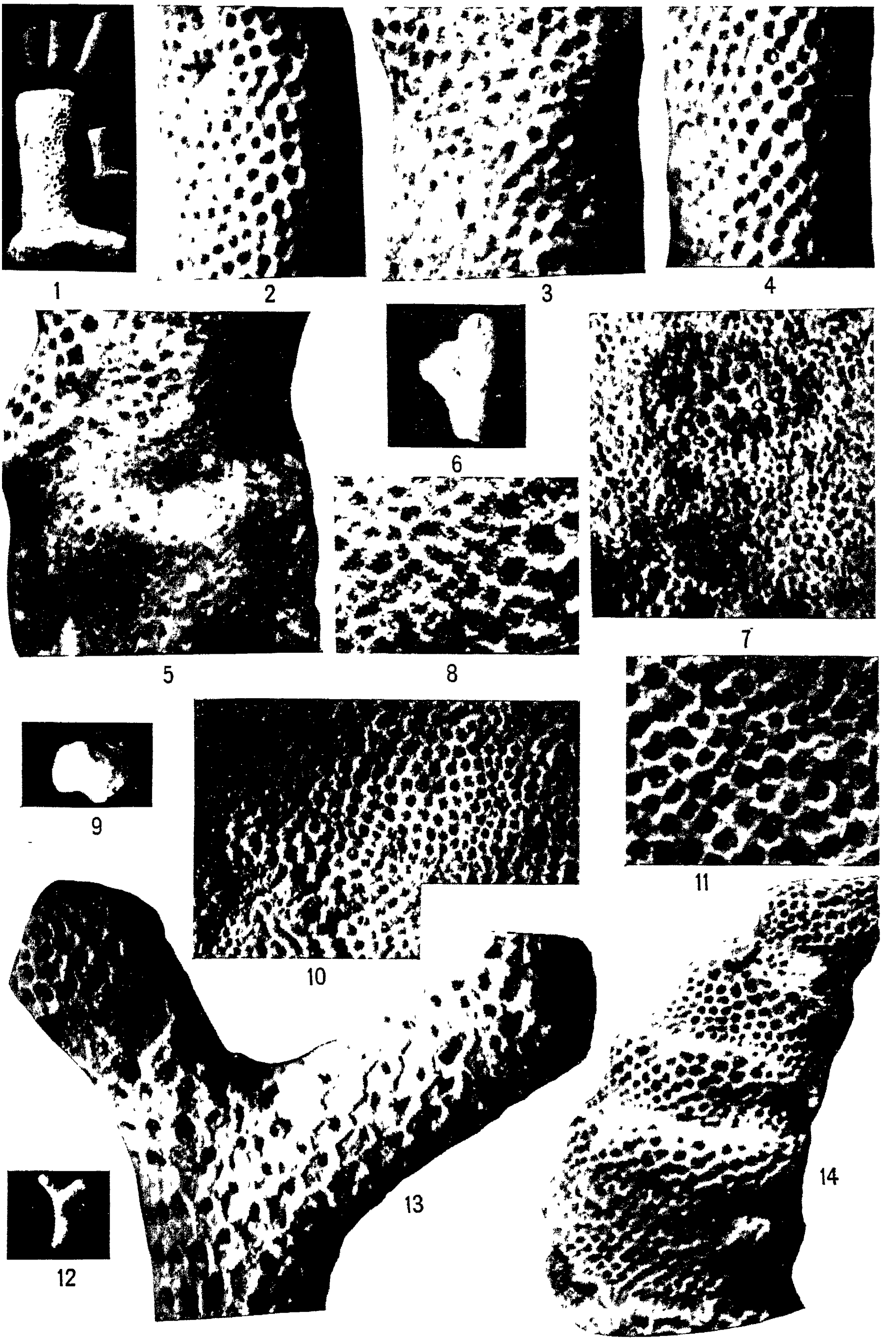
12, 13. A typical specimen, natural size and ×12, showing the transverse ovicell and the eleocellarium which is oval and longer than a facette.

Lower Cretaceous (Aptian): Faringdon, England.

FIG. 14. *Spiroclausa neocomiensis* De Loriol, 1863 .................... 75

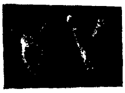
Specimen ×12, attributed doubtfully to this species but which is in reality a *Diplocava*.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.



Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 104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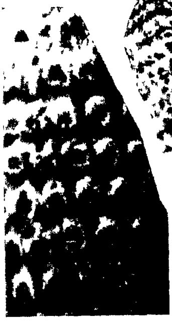
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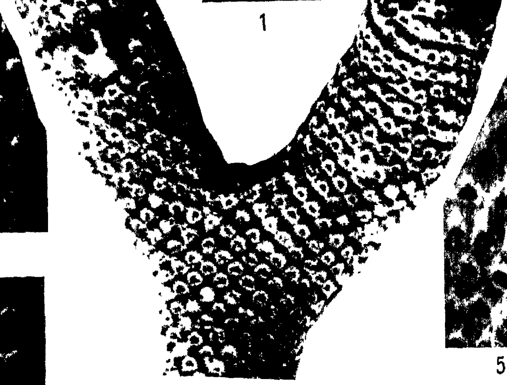
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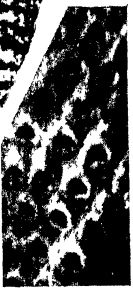
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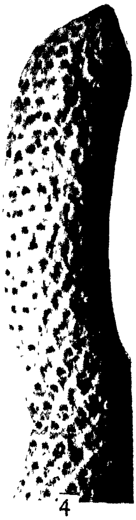
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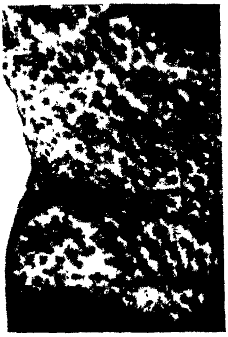
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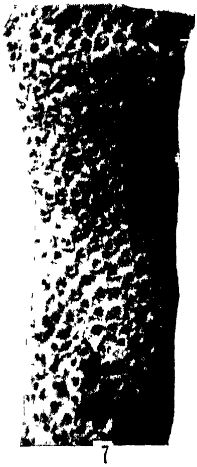
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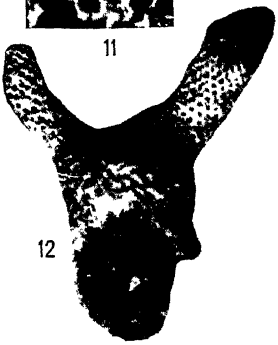
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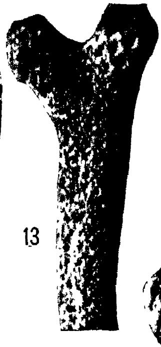
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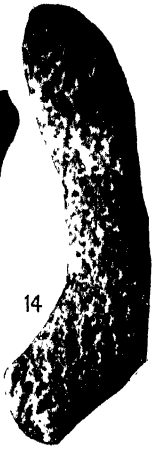
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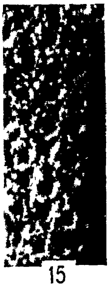
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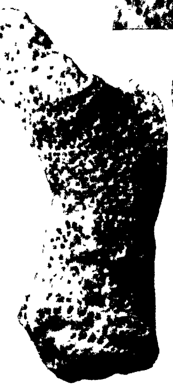
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 105

## PLATE 12

Page

FIGS. 1–12. *Meliceritites transversa,* new species ........................ 64
1. Two branches, natural size.
2, 3. Ovicelled specimen, ×12 and ×25. The peristomes are salient and arranged in transverse rows.
4. Zoarium, ×12, with peristomes little salient.
5. Same specimen as Figure 4, ×25. Portion where the peristomes are irregularly arranged.
6. Another surface of Figure 3, ×25, illustrating portion with peristomes arranged in oblique rows.
7. Multilameller specimen, ×12. The central zoarium is surrounded by two exterior lamellae.
8. Same specimen as Figure 7. Portion of an exterior lamella, ×25, showing peristomes irregularly arranged and a regenerated zooecium at the top.
9, 10. Zoarial base, ×6, and portion, ×12, showing the multiplicity of the exterior lamellae.
11. Portion of exterior lamellae same example, ×20, showing little salient, subcircular peristomes.
12. Basal part of zoarium, ×6.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 13–15. *Meliceritites,* species .................................... 67
13, 14. Two branches, ×12.
15. Surface, ×25.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 13

Page

FIGS. 1–8. *Meliceritites cunningtoni* Gregory, 1899.................... 65

1. Zoarial fragments, natural size.
2. A bifurcated branch, ×12, with the peristomes arranged in transverse rows.
3. Same specimen as Figure 2, ×25. Some of the tubes are operculated.
4. Portion of a branch, ×25, showing two denticulated eleocellaria.
5. A branch, ×25, illustrating that the eleocellarium results from the union of an orifice with the proximal pore.
6. Zoarial surface, ×25. The peristomes are arranged in quincunx.
7. Example, ×6, with the zoarial base somewhat expanded.
8. Branch, ×12, with peristomes arranged in quincunx.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 9–17. *Laterocava intermedia*, new species........................ 86

9. Two fragments, natural size.
10. Zoarial fragment, ×12, showing that the frontal face is covered by mesopores; the celluliferous faces are lateral.
11. The terminal branch of a specimen, ×12, with peristomes all around the colony.
12. Lateral celluliferous face, ×25.
13. Frontal face, ×25.

14, 15. An ovicelled specimen, ×12 and ×25.

16, 17. Example, ×12 and ×25. The ovicell is placed on the frontal face among the mesopores. The two branches are petaloporoid.

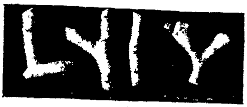
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 18–20. *Meliceritites haimeana* D'Orbigny, 1853.................. 64

18. Two fragments, natural size.

19, 20. Zoarium, ×12, and a portion, ×25.

Lower Cretaceous (Aptian): Faringdon, England.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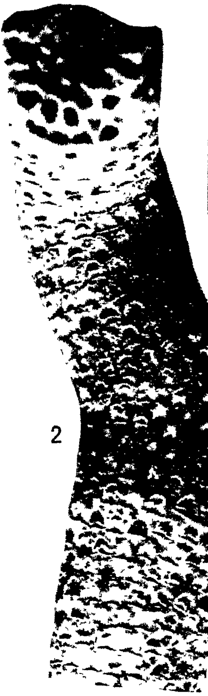
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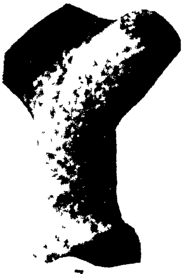
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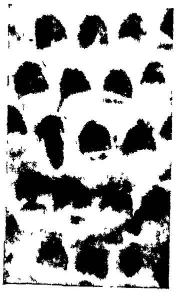
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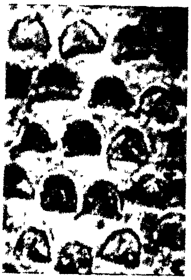
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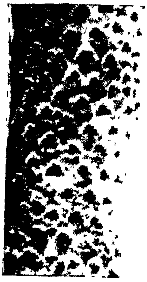
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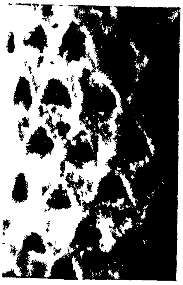
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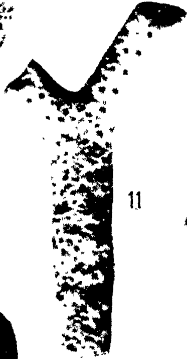
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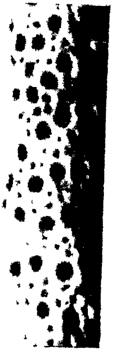
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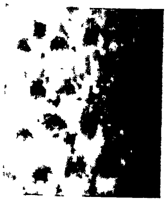
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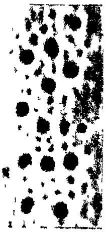
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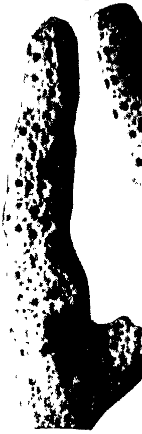
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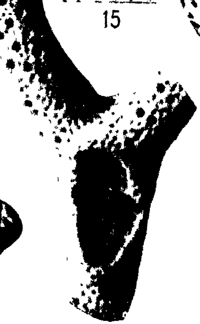
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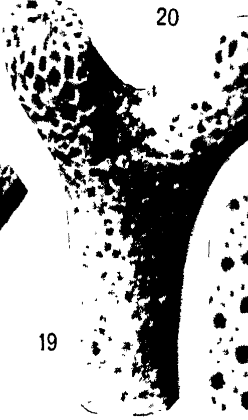
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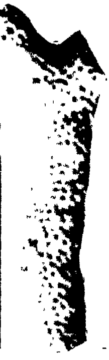
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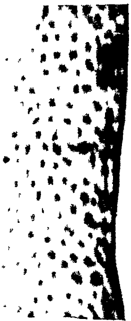
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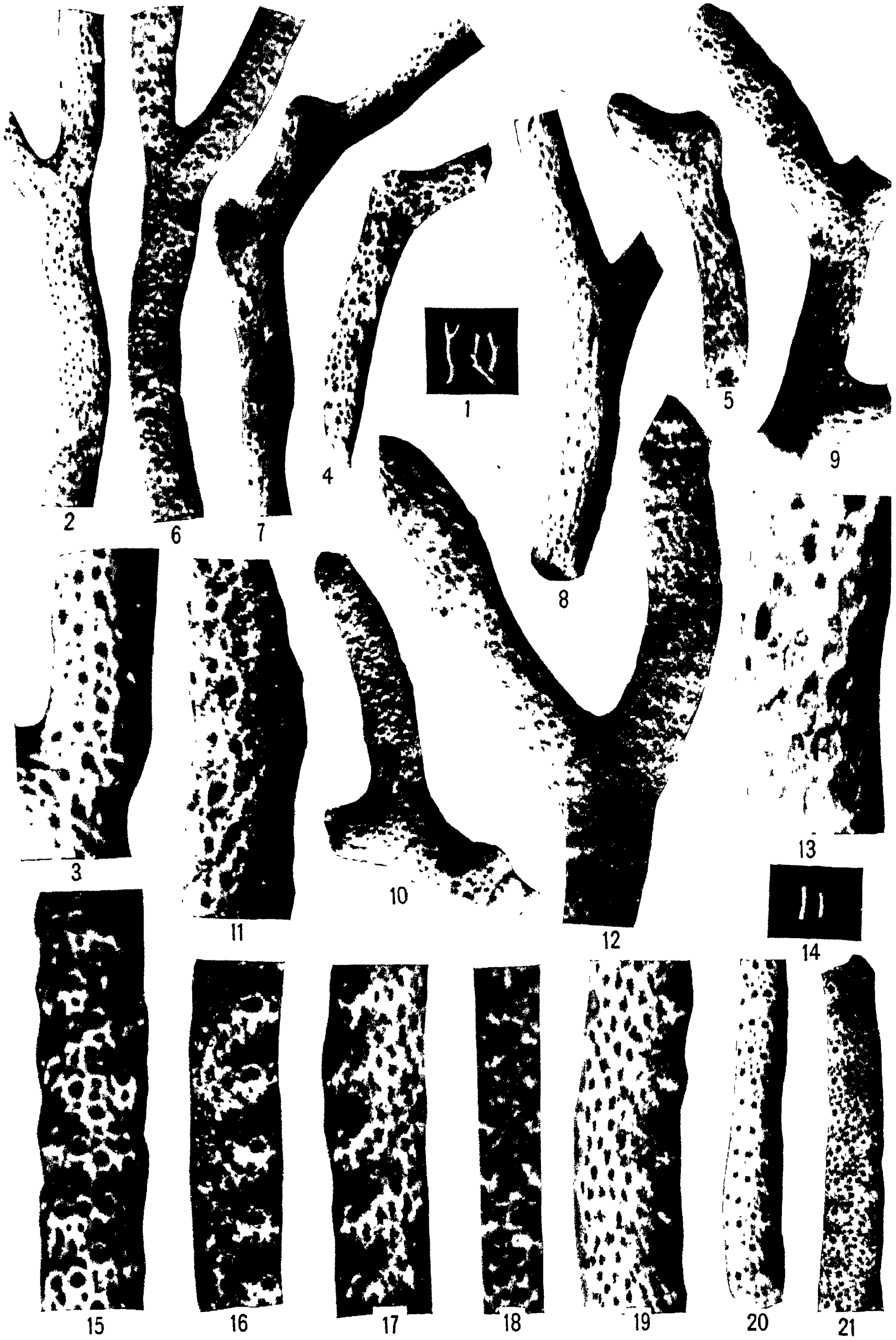
LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 106



LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 107

## PLATE 14

Page

FIGS. 1–11. *Siphodictyum irregulare*, new species ........................ 89

1. Zoarial fragments, natural size.
2. Noncellular posterior face of zoarium, ×12. The vacuoles are placed at the bottom of the oblique sulci.
3. Surface, ×25, showing the arrangement of the frontal vacuoles between the peristomes.

4, 5. The two faces of the same zoarium, ×12. The peristomes are arranged in quincunx.

6. Celluliferous (anterior) face, ×12. The peristomes are arranged in regular or interrupted transverse rows.

7, 8. Two zoaria, ×12. The celluliferous spaces alternate with the noncellular spaces.

9, 10. Two branches, ×12. At the extremity of the branches the peristomes are arranged entirely around the colony.

11. Same specimen as Figure 9, ×25.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 12, 13. *Lobosoecia semiclausa* Michelin, 1845 ........................ 63

12, 13. Branch, ×12 and ×25. The facettes are elongated.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 14–21. *Siphodictyum gracile* Lonsdale, 1849 ........................ 87

14. Two branches natural size.
15. Branch, ×25. The peristomes are incomplete or interrupted transverse lines. There are 4 to 6 vacuoles to a tube.
16. Lateral view of same specimen, ×25.
17. Dorsal view, ×25, with vacuoles placed at the bottom of the sulci.
18. Surface, ×25, with the peristomes placed in quincunx. There are 4 vacuoles to a tube.
19. Dorsal face, ×25. The vacuoles are at the bottom of the very oblique sulci.
20. Celluliferous face of a specimen, ×12. in which the orifices are arranged almost around the colony, the dorsal face being very small.
21. Dorsal side of the same specimen, ×12.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 15

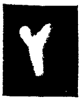
Page

FIGS. 1–6. *Laterocavea dutempleana* D'Orbigny, 1853 ........ 85
1, 2. A bifurcated frond, natural size and ×12, showing the broad celluliferous frontal face.
3. Celluliferous face, ×25.
4, 5. Lateral noncelluliferous face, ×12 and ×25.
6. Tangential thin section, ×25, showing the arrangement of the mesopores around the peristomes.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7–10. *Zonopora arborea* Koch and Dunker, 1837 ........ 90
7. Zoarial fragments, natural size.
8, 9. Portion of a specimen, ×12 and ×25, exhibiting no zones of mesopores.
10. Specimen, ×12, showing a false ovicell.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 11–14. *Sparsicavea irregularis* D'Orbigny, 1853 ........ 91
11. Specimens, natural size.
12. A reticulated specimen, ×12.
13. Specimen showing the large areas of mesopores, ×12.
14. Same specimen, ×25. The apertures are rounded and the mesopores are polygonal.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 15–17. *Zonopora compressa*, new species ........ 90
15. Fragments, natural size.
16, 17. A bifurcated frond, ×12, and portion, ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.



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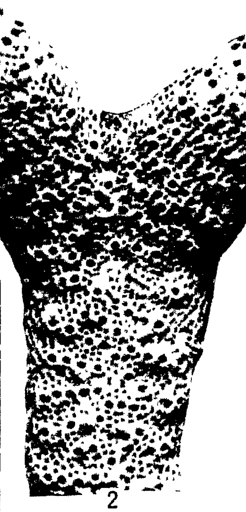

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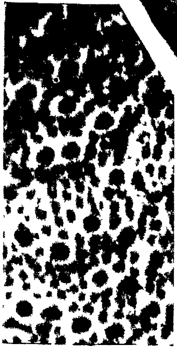

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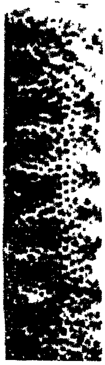

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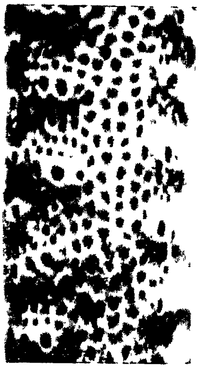

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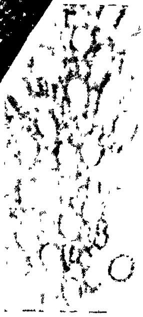

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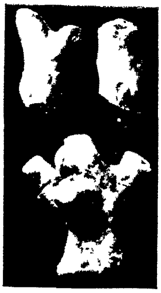

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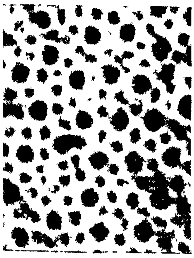

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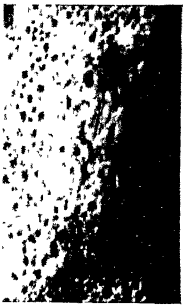

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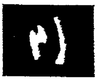

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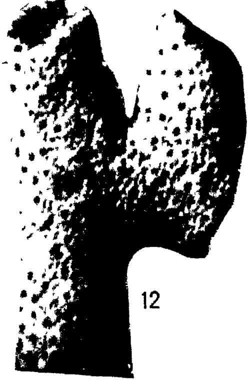

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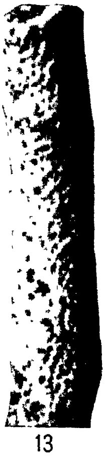

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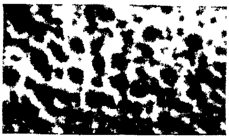

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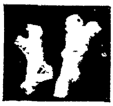

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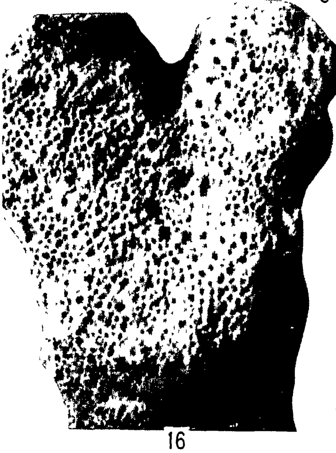

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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

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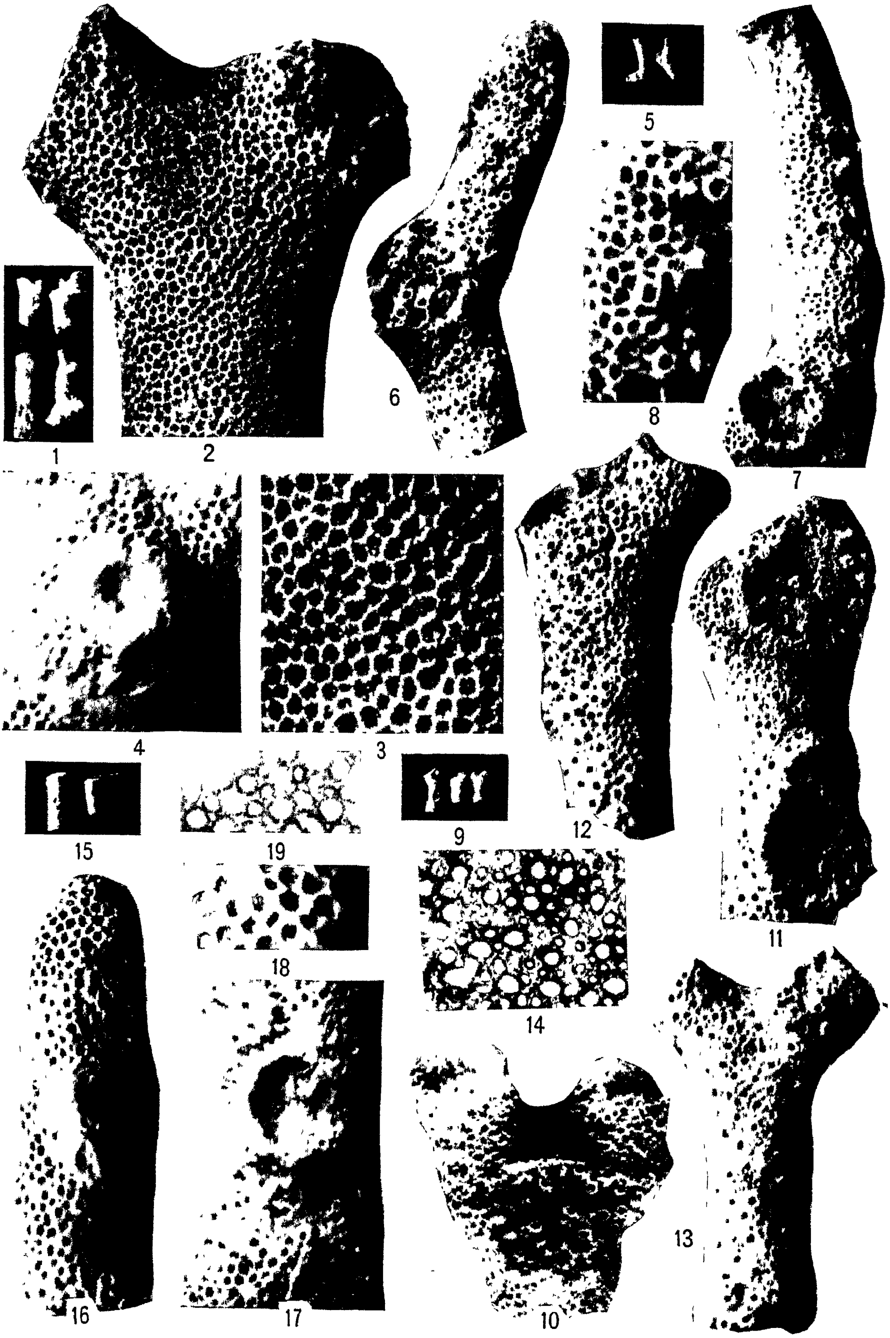

LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 109

## PLATE 16

Page

FIGS. 1–4. *Leiosoecia grandipora*, new species ........................ 77

1. Fragments, natural size.
2, 3. A bifurcated specimen, ×12, and surface, ×25. Mesopores are rare.
4. Ovicelled specimen, ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5–8. *Tretocycloecia multiporosa*, new species.................... 83

5. Branches, natural size.
6. Extremity of an ovicelled specimen, ×12.
7, 8. Ovicelled specimen, ×12, and surface, ×25. The ovicell is broken and incomplete.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 9–14. *Tretocycloecia densa*, new species ........................ 83

9. Zoarial fragments, natural size.
10. Ovicelled specimen, ×12. The ovicell shows a portion of the enclosing superior lamella.
11. Ovicelled specimen, ×12, exhibiting the transverse section of a broken branch.
12. Specimen with salient peristomes, ×12.
13. Bifurcated, ovicelled fragment, ×12.
14. Tangential section, ×25.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 15–18. *Leiosoecia aequiporosa*, new species .................... 75

15. Fragments, natural size.
16. Extremity of an ovicelled branch, ×12.
17. Specimen, ×12, showing the internal structure of the ovicell.
18. Portion of Figure 16, ×25.
19. Tangential thin section, ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## Plate 17

Page

Figs. 1–5. *Leiosoecia constanti* D'Orbigny, 1850 ........................ 77

1. Two fragments, natural size.

2, 3. A mammillated specimen, ×12 and ×25, showing the polygonal orifices and the small mesopores.

4. Portion of an ovicelled branch with large mesopores, ×12.

5. Surface, ×12, with large mesopores and showing a circular area of mesopores.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

Figs. 6, 7. *Clausa cranei*, new species ........................ 79

6. Young zoarium, ×12, with the peristomes arranged in transverse rows.

7. Same zoarium, ×25. Extremity showing tubes of the same size and revealing peripheral gemmation.

Lower Cretaceous (Aptian): Faringdon, England.

Figs. 8–11. *Clausa zonifera*, new species ........................ 80

8, 9. Specimens, natural size and several ×2.

10. Young zoarium, ×12, showing the zones of dactylethrae.

11. Same specimen, ×25, illustrating the arrangement of dactylethrae around the orifices.

Lower Cretaceous (Aptian): Faringdon, England.

Figs. 12–15. *Leiosoecia proxima*, new species ........................ 79

12. Zoarial fragments, natural size.

13. Specimen with convex ovicell, ×12.

14. Specimen with ovicell little convex, ×12.

15. Surface, ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

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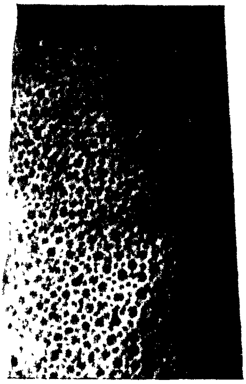
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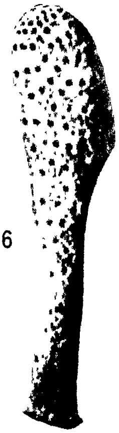
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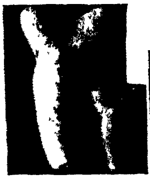
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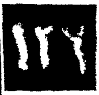
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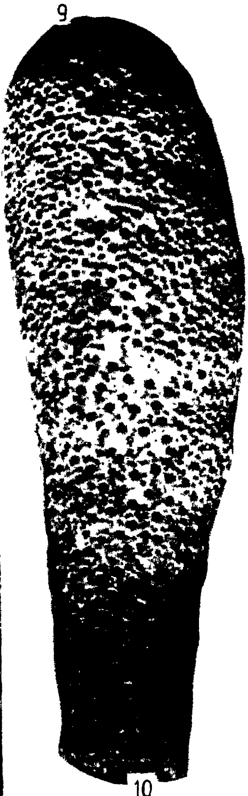
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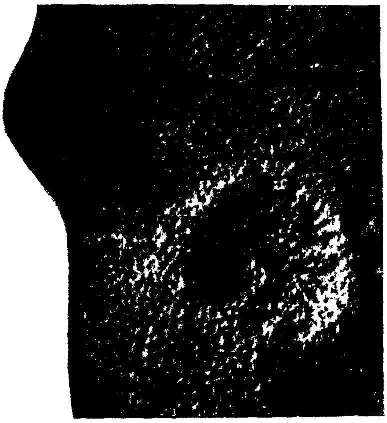
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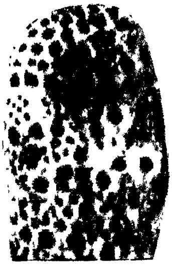
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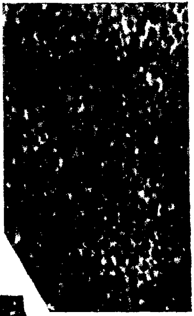
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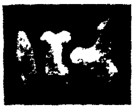
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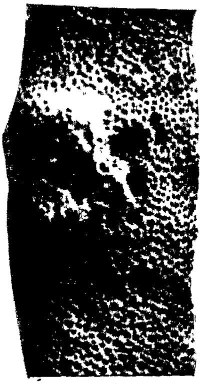
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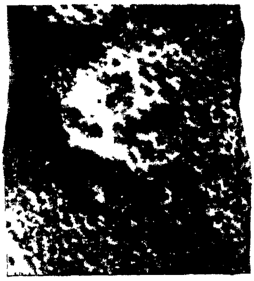
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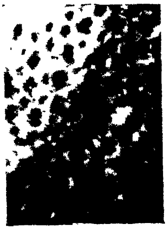
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

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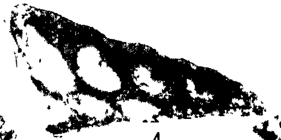

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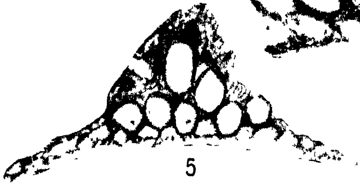

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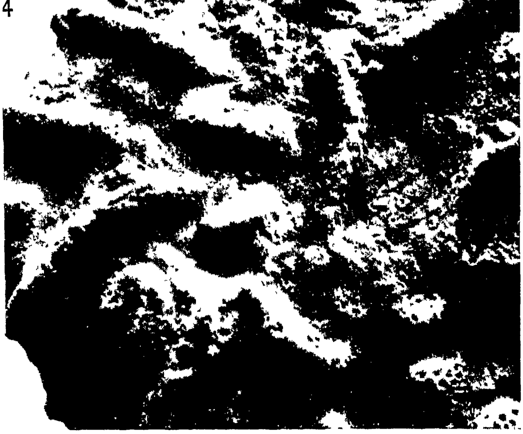

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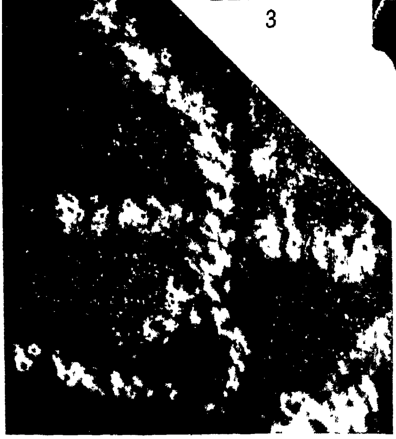

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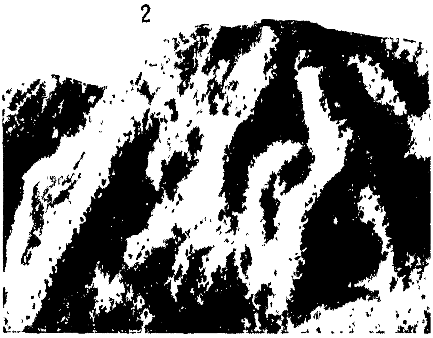

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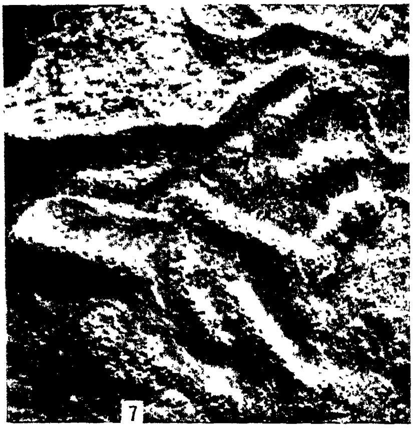

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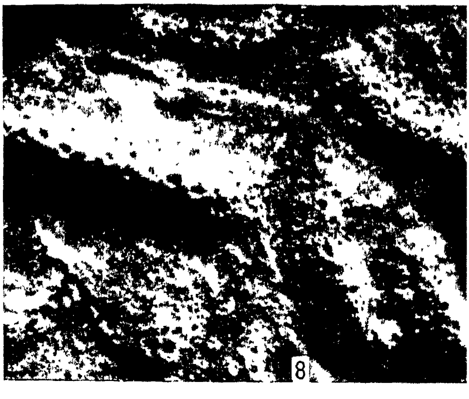

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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 111

## PLATE 18

Page

FIG. 1. *Reptoclausa denticulata*, new species ........................ 82
The encrusting zoarium, ×6.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 2–5. *Reptoclausa hagenowi* Sharpe, 1854 ........................ 82
2. An encrusting zoarium, ×6.
3. Lateral view of a fascicle, ×12.
4. Longitudinal section, ×25, showing the thickness of the crest and the oblique arrangement of the tubes.
5. Transverse section of a branch, ×25.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 6–8. *Reptoclausa meandrina* DeLoriol, 1868 ........................ 82
6, 7. Portions of the same zoarium, ×6, on opposite sides of a shell.
8. Branches of a zoarium, ×12.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 19

Page

FIGS. 1–6. *Multigalea canui* Gregory, 1909 61

1. The massive zoarium, natural size formed of a large number of superposed subcolonies.
2. Two subcolonies, ×12. At the left the tubes are provided with visors.
3. Tubes, ×25, with their triangular visors. The cancelli are irregular.
4. Almost complete ovicell, ×12. The branches are not symmetrical.
5. Surface, ×12, with an ovicell, in part broken, showing the internal lines of tubes in radial arrangement.
6. Surface, ×25, showing tubes without visors. The walls are thick.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7–10. *Multigalea marginata*, new species 62

7. Lateral view of zoarium, natural size.
8. Two subcolonies, ×12, with their smooth margins.
9. Marginal lamella af a subcolony, ×12.
10. Worn portion of a subcolony, ×12. The cancelli are little distinct from the tubes.

Lower Cretaceous (Aptian): Faringdon, England.

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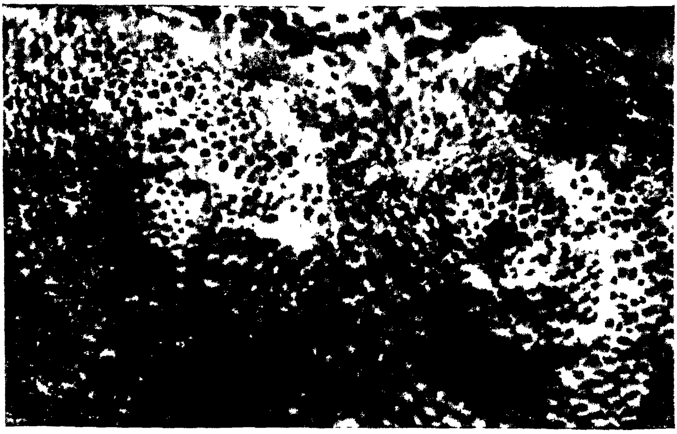
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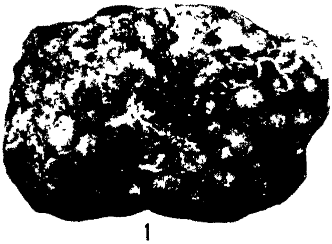
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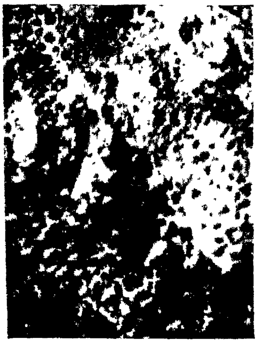
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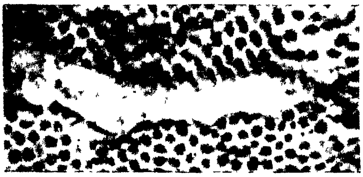
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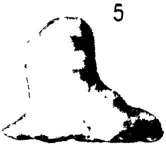
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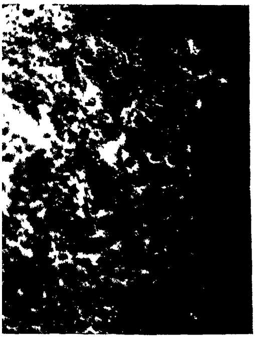
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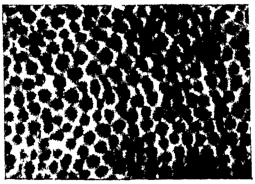
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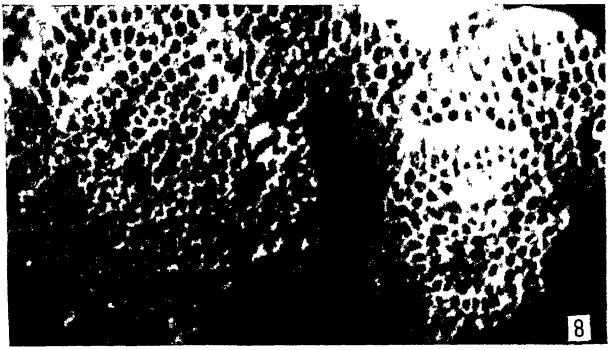
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Lower Cretaceous Cyclostomatous Bryozoa

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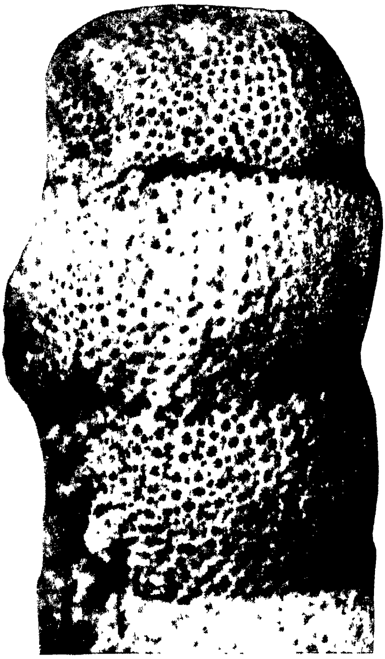
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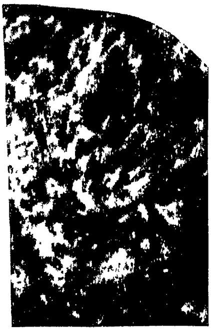
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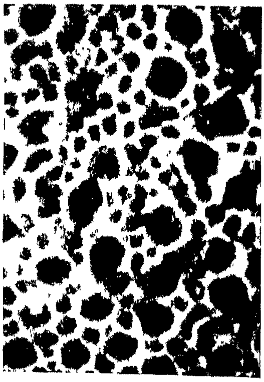
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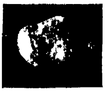
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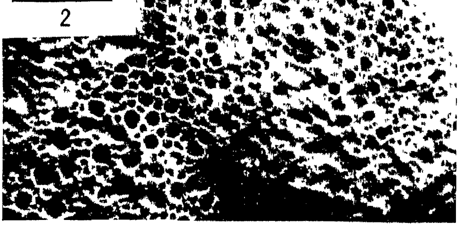
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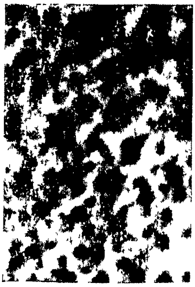
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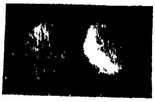
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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 113

## PLATE 20

Page

FIG. 1. *Tholopora virgulosa* Gregory, 1909 ........ 63

Zoarium, ×12, formed of four superposed subcolonies.

Lower Cretaceous (Aptian): Faringdon, England.

FIG. 2–5. *Radiopora tuberculata* D'Orbigny, 1849 ........ 63

2. Zoarium, natural size.
3. Two subcolonies, ×12, showing the large diameter of the tubes.
4. A portion of the surface, ×25.
5. Base of a zoarium, ×12, showing the fan-shaped arrangement of the tubes.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 6–8. *Heteropora nummularia*, new species ........ 13

6. Zoarium, natural size.

7, 8. Surface, ×12 and ×25.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 9–11. *Multicrescis parvipora*, new species ........ 14

9. Two zoaria, natural size.

10, 11. Portion of the zoarial surface, ×12 and ×25, showing the small irregular oval visors.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 12–15. *Multicrescis landrioti* Michelin, 1841 ........ 15

12, 13. Top and basal view of a large zoarium, natural size.

14, 15. Zoarial surface, ×12 and ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## Plate 21

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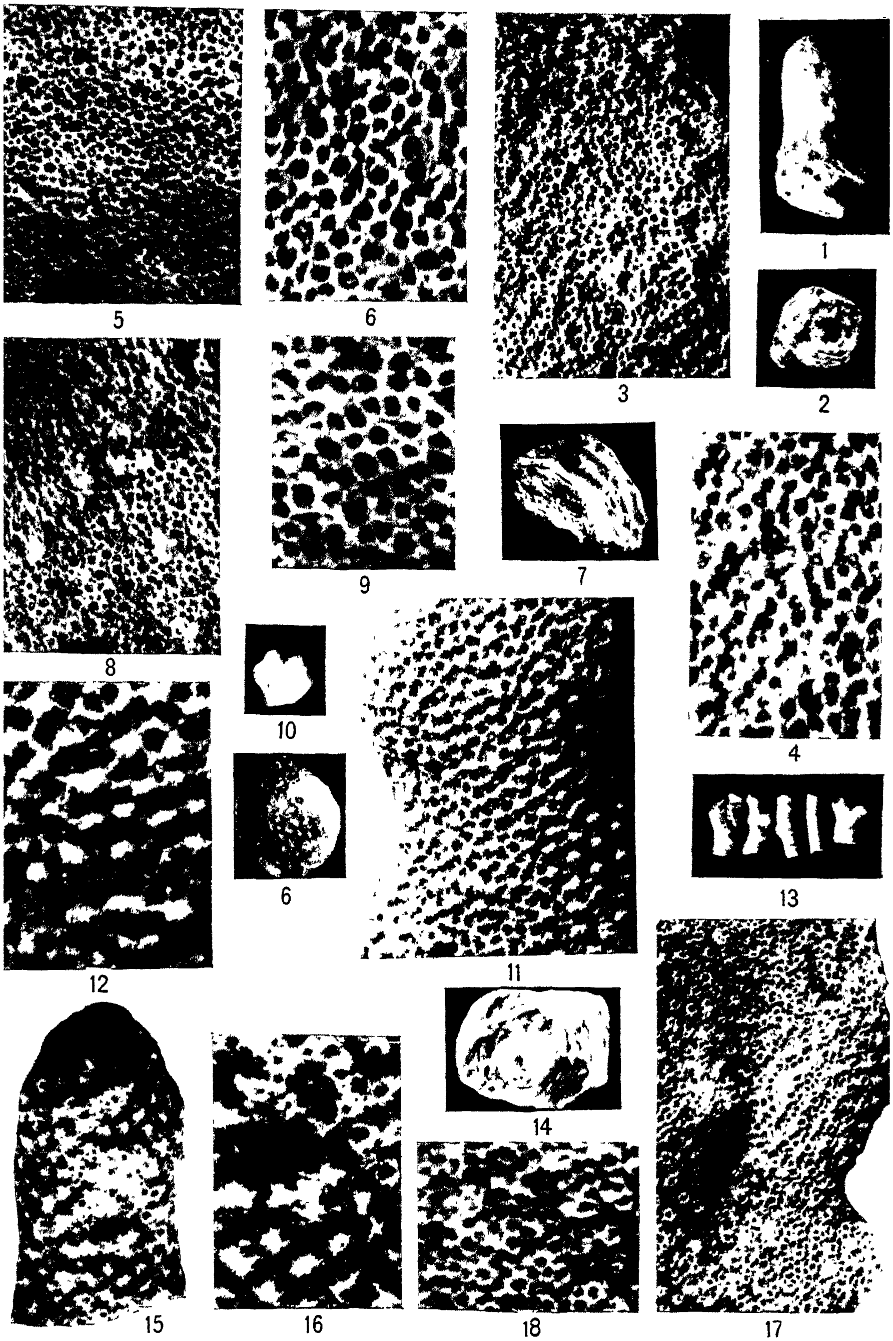
FIGS. 1–4. *Multicrescis galaefera*, new species ------------------------ 14
1, 2. Lateral and basal views of zoarium, natural size.
3, 4. Surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5–6. *Multicrescis mammillosa*, new species ---------------------- 16
Surface, ×12 and ×25.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7–9. *Multicrescis lamellosa*, new species ------------------------ 16
7. Portion of the lamellate zoarium, natural size.
8, 9. Zoarial surface, ×12 and ×25, showing the great irregularity of the mesopores and apertures.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

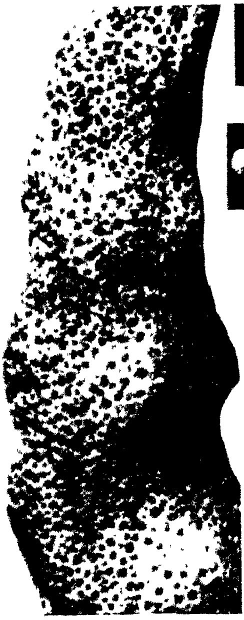
FIGS. 10–12. *Multicrescis* (*Acanthopora*) *formosa*, new species ----------- 18
10. Fragment of zoarium, natural size.
11, 12. Surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 13–18. *Multicrescis pulchella*, new species ---------------------- 17
13. Zoarial fragments, natural size.
14. Zoarial base, ×3, showing the central stem surrounded by encrusting lamellae.
15, 16. Specimen, ×12 and ×25, with very salient visors.
17, 18. Zoarial fragment, ×12 and ×25, showing the small visors and the oblique apertures.
Lower Cretaceous (Valangian): Sainte-Croix Switzerland.



LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 114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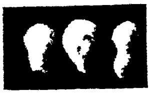
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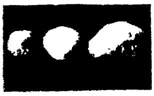
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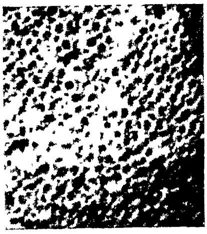
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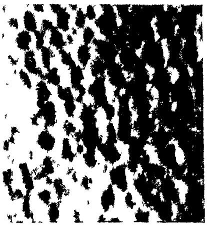
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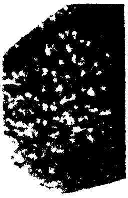
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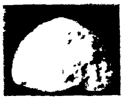
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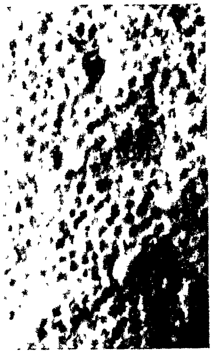
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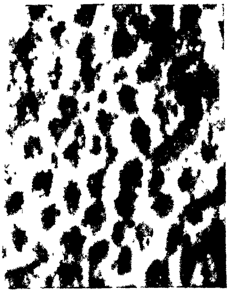
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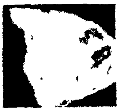
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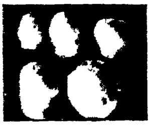
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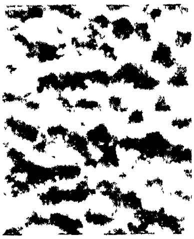
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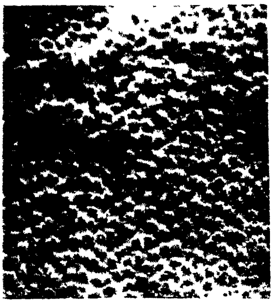
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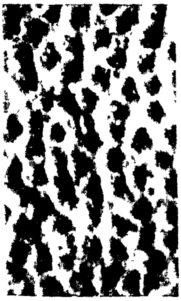
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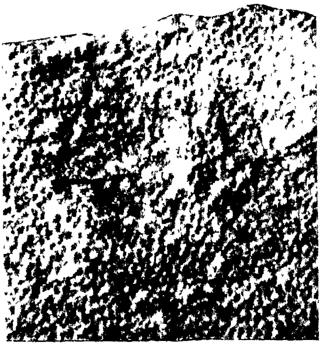
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 115

## PLATE 22

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FIG. 1. *Seminodicrescis nodosa* D'Orbigny, 1854 ---------- 19
Part of zoarium, ×12.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 2–5. *Ceriopora ovoidea*, new species ---------- 21
2. Three zoaria, natural size.
3, 4. Aspect of the surface, ×12 and ×25.
5. View of the base, ×6, showing tubes radiating from the ancestrula.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 6–8. *Ceriopora solida*, new species ---------- 24
6. The solid zoarium, natural size.
7, 8. Surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 9–11. *Ceriopora aequipedis*, new species ---------- 24
9. Three zoaria, natural size.
10, 11. Portion of the surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 12–14. *Ceriopora tenuis*, new species ---------- 21
12. Zoarium, natural size.
13, 14. Surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 15–17. *Ceriopora angustipedis*, new species ---------- 23
15. Group of small colonies, natural size.
16, 17. Portion of the zoarial surface, ×12 and ×25.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 23

Page

FIGS. 1–4. *Ceriopora nummularia*, new species ---------------------- 26
  1. Zoarium, natural size.
  2, 3. Fragment of the zoarial surface, ×12 and ×25.
  4. Base of a zoarium, ×12, showing the arrangement of the tubes around the ancestrula.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5–7. *Ceriopora parvipora*, new species ---------------------- 25
  5. Zoarium, natural size.
  6, 7. Part of the zoarial surface, showing the small oral tuberosities, ×12 and ×25.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 8–10. *Ceriopora fallax*, new species ---------------------- 28
  8. Two zoaria, natural size.
  9, 10. Fragment of the superior part of the zoarium, showing the large and small aperture, ×12 and ×25.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 11–17. *Ceriopora lobifera*, new species ---------------------- 27
  11, 12. Specimens with short and irregular lobes, natural size.
  13, 14. Zoarium, natural size, and base of same, ×12.
  15, 16. Zoarial surface, ×12 and ×25.
  17. Portion of the sectioned zoarium showing the mammillosities of the surface, ×6.
  Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

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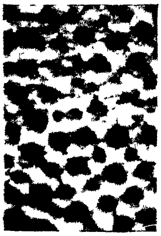
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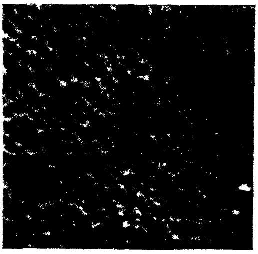
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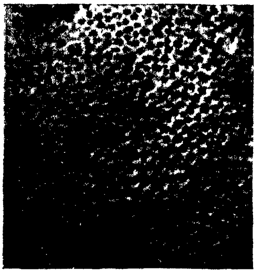
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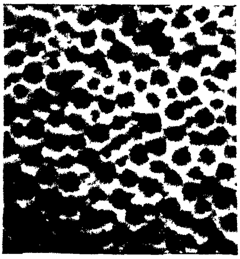
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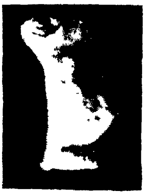
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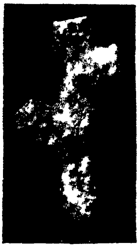
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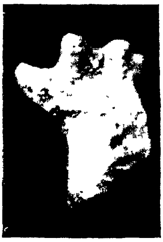
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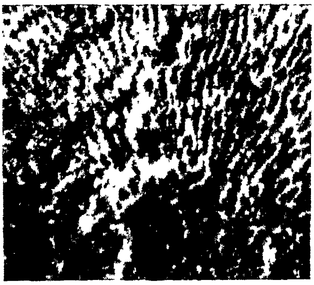
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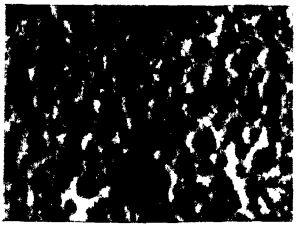
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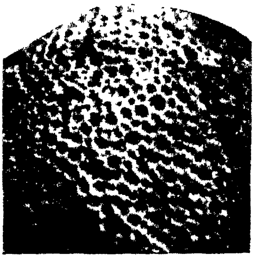
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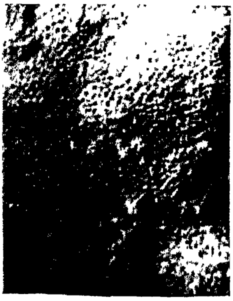
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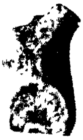
Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 116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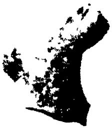
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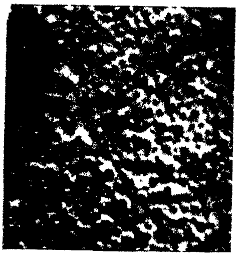
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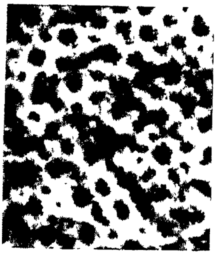
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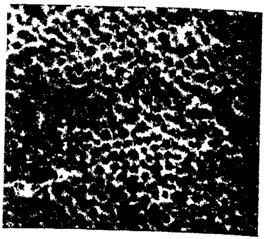
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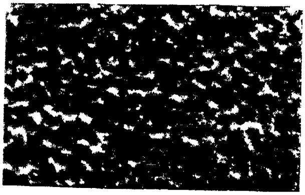
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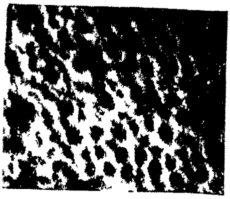
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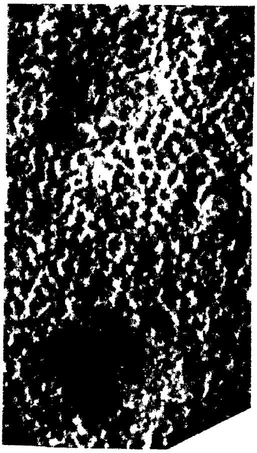
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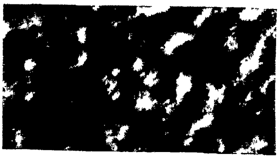
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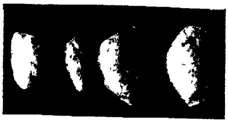
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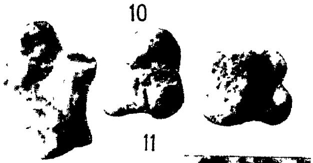
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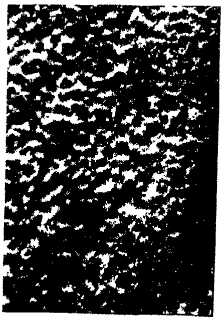
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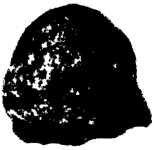
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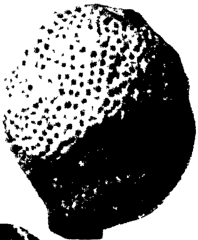
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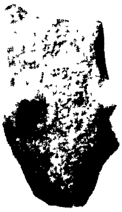
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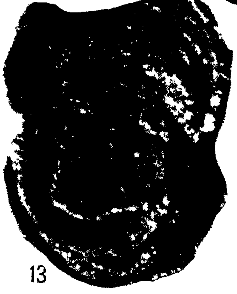
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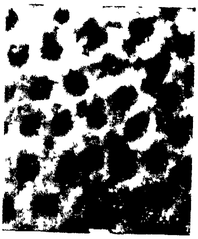
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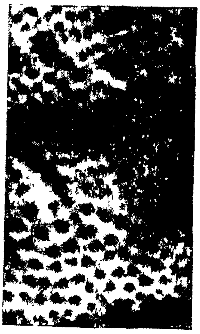
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 117

## PLATE 24

Page

FIGS. 1–6. *Ceriopora dimorphocella*, new species ........................ 29
- 1, 2. Two fragments of the ramose zoarium, natural size.
- 3, 4. Portion of zoarial surface, ×12 and ×25, showing the small oral tongues.
- 5, 6. Surface of a colony, ×12 and ×25, less well preserved and with oral tongues very rare.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7–10. *Ceriopora spongioides*, new species ........................ 28
- 7. Four zoaria, natural size.
- 8. Zoarial surface, with traces of ovicell, ×12.
- 9, 10. Zoarial surface, ×12 and ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 11–17. *Reptomulticava fungiformis* Gregory, 1909 ........................ 29
- 11. Three zoarial forms, natural size.
- 12, 13. Lateral view, ×3, and basal view, ×6, of a massive specimen with several superposed lamellae.
- 14, 15. Globular specimen, ×6 and surface of same, ×25.
- 16, 17. Zoarial surface, showing several superposed lamellae, ×12 and 25.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 18–20. *Reptomulticava bellula* De Loriol, 1869 ........................ 30
- 18. Zoarium, ×2.
- 19, 20. Surface, ×12 and ×25.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

## PLATE 25

Page

FIGS. 1–3. *Neuropora arbuscula*, new species........................ 32

1. Two zoaria, natural size.

2, 3. Zoarial surface, ×12 and ×25, showing the salient interapertural tuberosities.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 4–8. *Neuropora micropora*, new species........................ 33

4. Zoaria, natural size.

5, 6. Portion of the surface, ×12 and ×25, showing the irregularities.

7. Surface, ×25, exhibiting oral denticulations.

8. Tangential section, ×25, illustrating structure of the tubes. There are some solidified groups.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 9–12. *Neuropora ramosa*, new species........................ 32

9. Two zoaria, natural size.

10. Portion of surface of specimen without veinules, ×12.

11. Extremity of a zoarial lobe with a veinule, ×12.

12. Surface, ×25, showing the oral tuberosities forming visors.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 13–15. *Defranciopora neocomiensis*, new species........................ 30

13. Zoarium, natural size.

14, 15. Zoarial surface, ×12 and ×25, at the extremity of the colony.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 16–19. *Neuropora tenuinervosa*, new species........................ 33

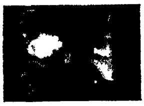
16. The solid ramose zoarium, natural size.

17. Specimen with delicate veinules, ×12.

18. Portion of a specimen without veinules, ×12.

19. Portion of the surface, ×25, showing the zooecial asperities and the oral denticulations.

Lower Cretaceous (Aptian): Faringdon, England.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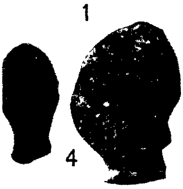
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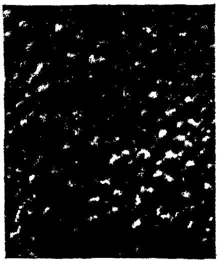
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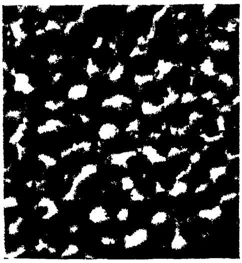
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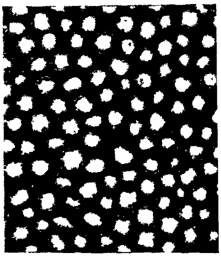
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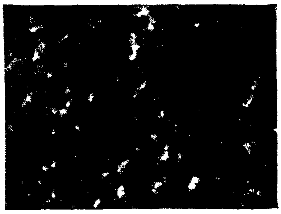
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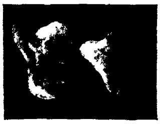
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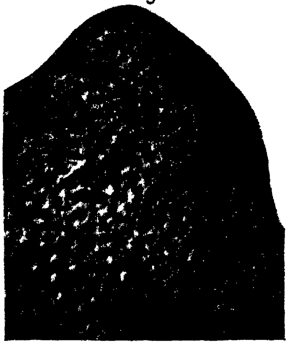
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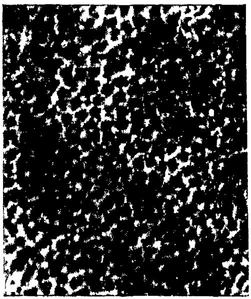
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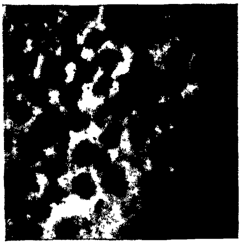
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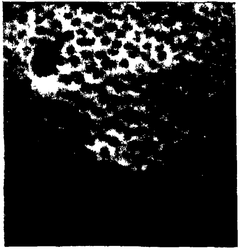
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LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

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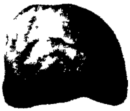
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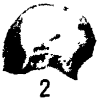
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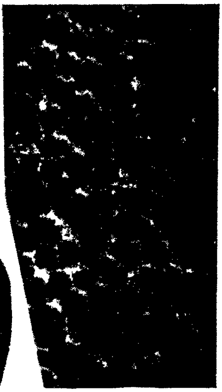
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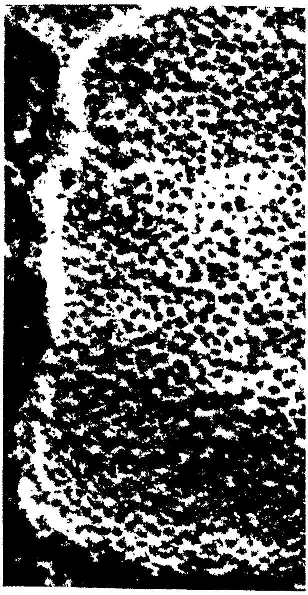
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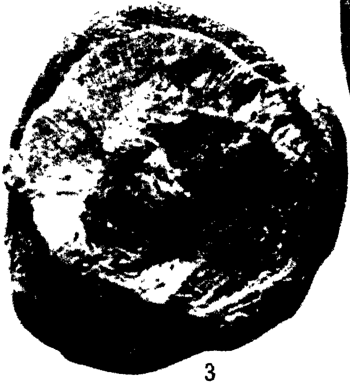
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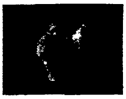
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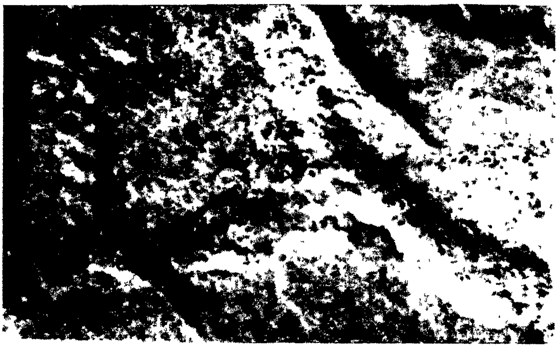
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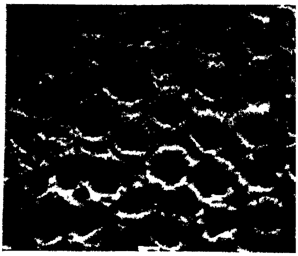
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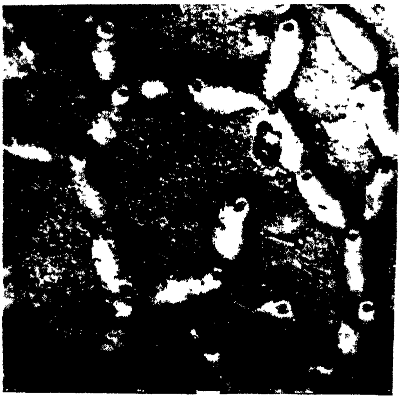
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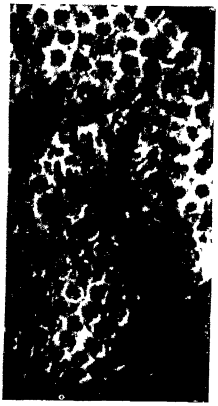
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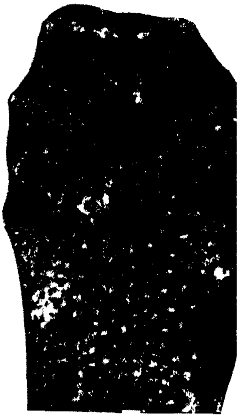
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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 119

## PLATE 26

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FIGS. 1–5. *Neuroporella hemispherica*, new species .................... 34

1, 2. Lateral views of two zoaria, natural size.

3. Basal side of specimen, ×3, showing the arrangement of the tubes and the superposed lamellae.

4. Portion of the surface, ×12, with the salient veinules.

5. Portion, ×25, showing the details of the surface and of the orifices.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 6, 7. *Spinopora neocomiensis*, new species .................... 35

Branch of zoarium, natural size and ×12, with its wide-spaced salient tuberosities and its numerous small oral asperities.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 8, 9. *Cellulipora spissa* Gregory, 1899 .................... 6

8. Specimen, ×12, showing possibly a trace of ovicell.

9. Orifices, ×25.

Lower Cretaceous (Aptian): Faringdon, England.

FIG. 10. *Proboscina toucasiana* D'Orbigny, 1853 .................... 6

Complete zoarium, ×12.

Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 11. *Stomatopora calypso* D'Orbigny, 1850 .................... 5

Portion of zoarium, ×12.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 27

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FIGS. 1, 2. *Proboscina radiolitorum* D'Orbigny, 1851 ------------------ 7
Zoarium, ×12, and a portion, ×25.
Lower Cretaceous (Aptian): Faringdon, England.

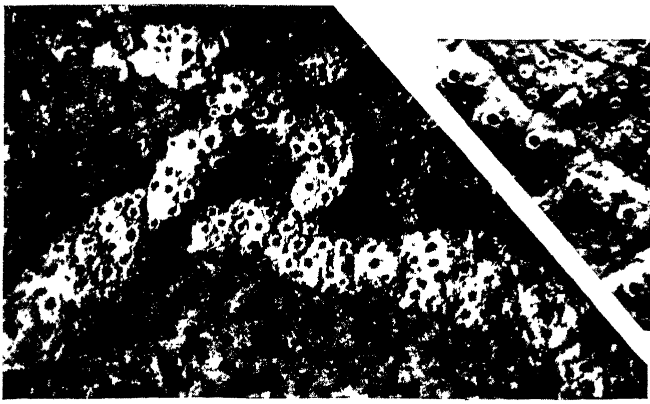
FIG. 3. *Proboscina crassa*, var. *alectodes* Gregory, 1899 ----------------- 6
Zoarium, ×12.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIG. 4. *Berenicea confluens* Reuss, 1846 ------------------------------ 9
The discoid, incrusting zoarium, ×12.
Lower Cretaceous (Valangian): Sainte-Croix, Switzerland.

FIGS. 5, 6. *Proboscina depressa* D'Orbigny, 1853 --------------------- 8
Zoarium, ×12 and ×25.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7, 8. *Proboscina ricordeauana* D'Orbigny, 1853 ------------------ 7
Zoarium, ×12, and portion, ×25.
Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 9, 10. *Proboscina virgula* D'Orbigny, 1853 ---------------------- 8
Zoarium, ×12 and ×25.
Lower Cretaceous (Aptian): Faringdon, England.



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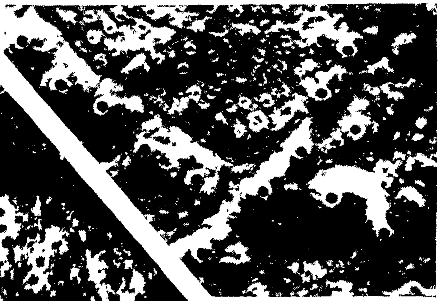

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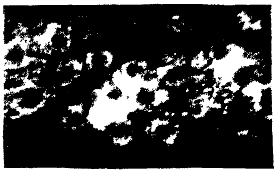

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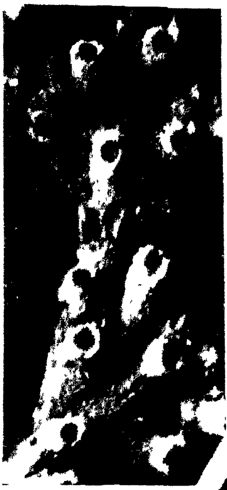

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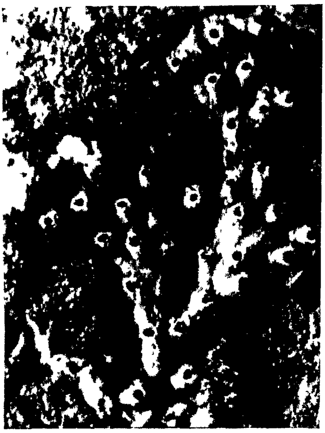

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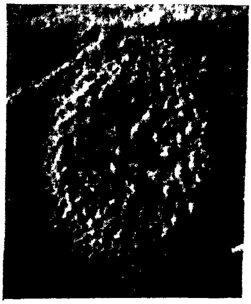

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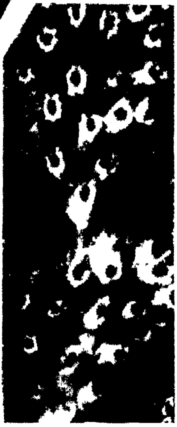

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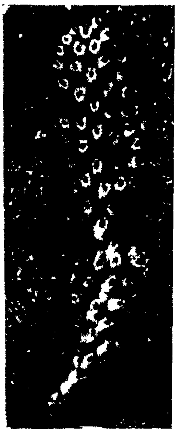

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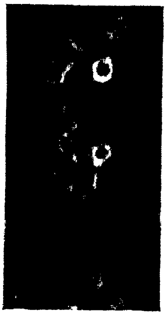

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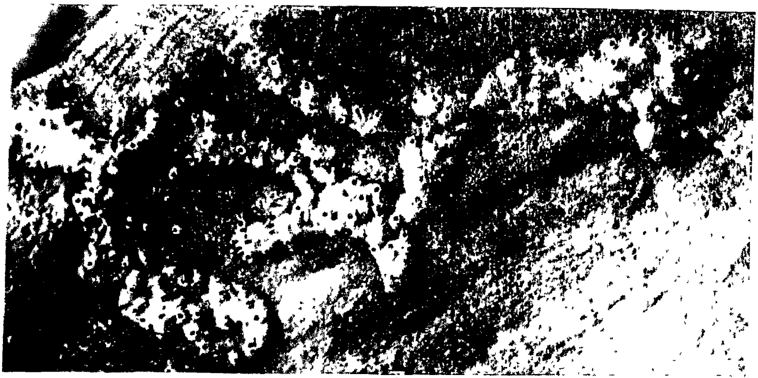
LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 120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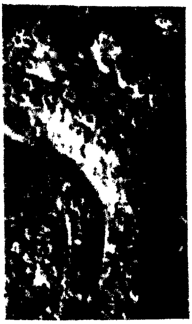
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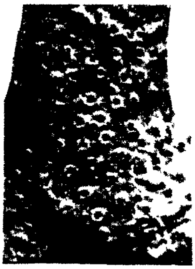
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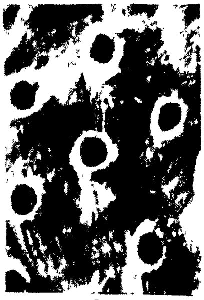
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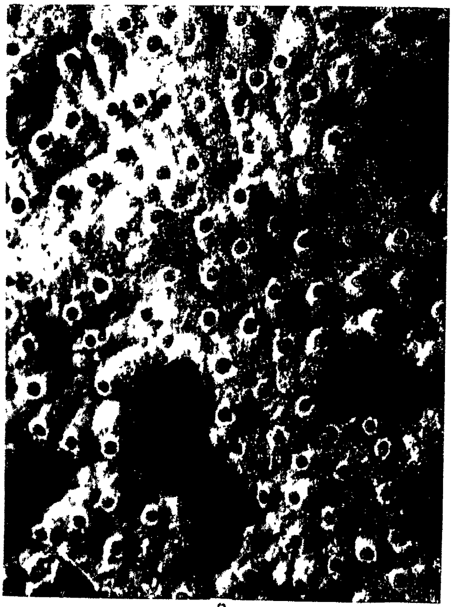
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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 121

## PLATE 28

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| FIGS. 5–7. | *Microecia cornucopia* D'Orbigny, 1851<br>5. Ovicelled specimen, ×12.<br>7, 8. Unovicelled example, ×12 and ×25.<br>Lower Cretaceous (Aptian): Faringdon, England. | 37 |
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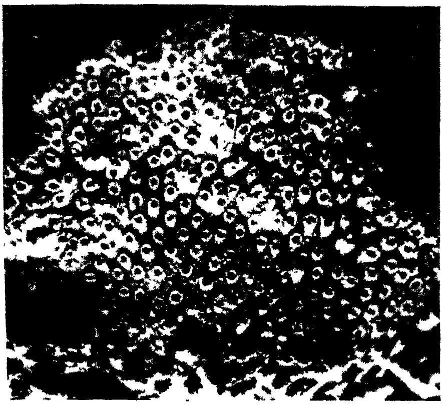
| FIGS. 8–11. *Clinopora quadripartita*, new species<br>8. Fragment, natural size.<br>9. Specimen, ×12 showing several bifurcations.<br>10, 11. Specimen, ×12 and ×25. showing the arrangement of the anastomosing threads ornamenting the surface.<br>Lower Cretaceous (Aptian): Faringdon, England. | 12 |



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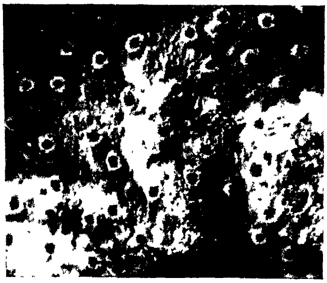

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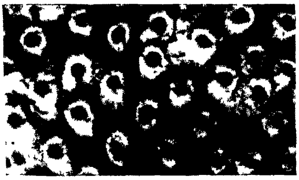

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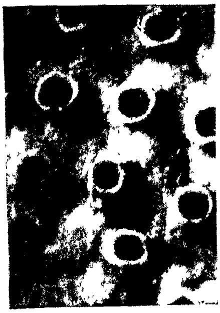

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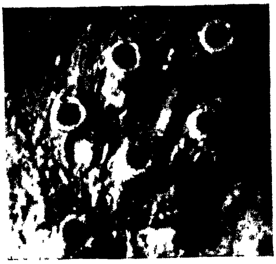

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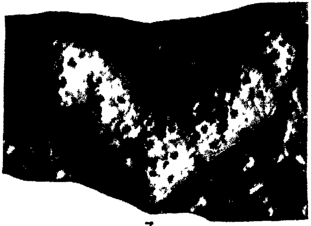

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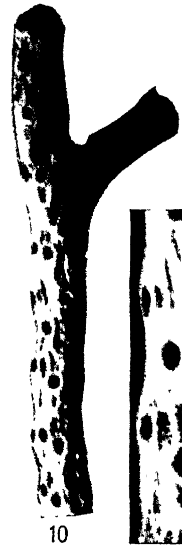

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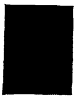

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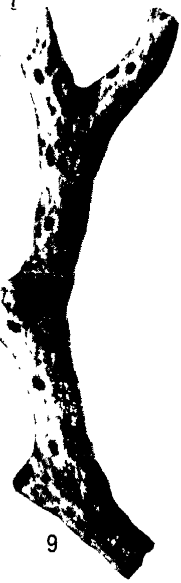

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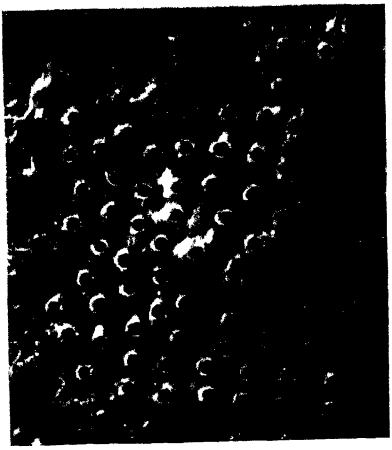

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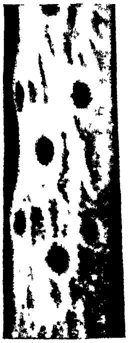

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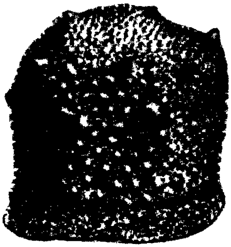
LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 122



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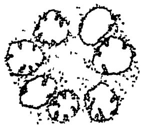

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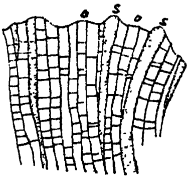

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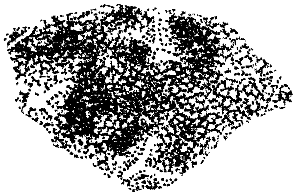

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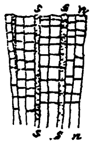

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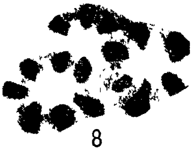

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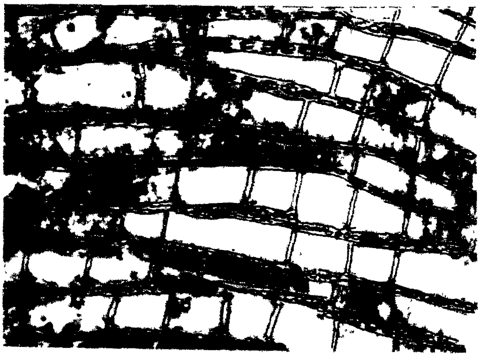

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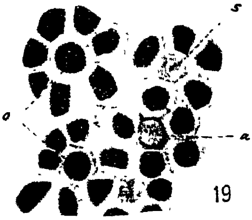

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Lower Cretaceous Cyclostomatous Bryozoa

For explanation of plate see page 123

## PLATE 30

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Figs. 1–4. *Spinopora mitra* Goldfuss, 1827 34

1, 2. Colony, natural size, and the same enlarged.

3. Longitudinal section, ×9, showing the tubes (*o*) with numerous diaphragms, and the solidified wide tubes (*s*), forming the spinous tuberosities of the surface.

4. Tangential section, ×26, showing the irregular spines which line the interior of the tubes.

(1–4, after Hennig, 1894.)

Figs. 5–8. *Neuroporella ignabergensis* Hennig, 1894 34

5, 6. Colony, natural size, and the surface enlarged, showing the nervures and the centers of convergence.

7. Meridian section, showing the structure of the tubes, with numerous diaphragms, and of the solidified tube (*s*), corresponding to the nervures.

8. Tangential section through a portion with nervures.

(5–8, after Hennig, 1894.)

Figs. 9–19. *Neuropora conuligera* Hennig, 1893 32

9–12. Lateral view of four colonies, natural size.

13. Superior view of a lobe, ×12, showing the nervures and their center of convergence, *a*.

14. Longitudinal section, ×4.

15. Portion of a longitudinal section, ×25, showing the reciprocal arrangement of the tubes, with diaphragms and their thickened vesicular walls (*p*).

16. Portion of a longitudinal section, ×9, showing false zonal lines and the structure of the zooecial walls.

17. Portion of a transverse section, ×18. The central portion *a* is formed of ascending bundles of tubes; the peripheral portion *b* shows the recurved part of the tubes, with their usual structure.

18. Central part of a transverse section, ×75, showing the polygonal zooecia and the walls (*p*) of parietal vesicles.

19. Tangential section, ×18, exhibiting the solidified tubes *a*, *s*, forming the nervures.

(9–19, after Hennig, 1893.)

Fig. 20. *Neuropora micropora*, new species 33

Longitudinal section, ×50, showing the microscopic structure of the walls.

Lower Cretaceous (Aptian): Faringdon, England.

## PLATE 31

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FIG. 1. *Zonopora compressa*, new species ............................ 90

Portion of transverse section, ×25.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 2–4. *Zonopora arborea* Koch and Dunker, 1837 ..................... 90

2. Transverse section, ×25.

3, 4. Tangential section, ×12 and ×25.

Lower Cretaceous (Neocomian): Berklingen, Germany.

FIGS. 5, 6. *Neuroporella hemispherica*, new species ....................... 34

5. Meridian section, ×25, showing the internal structure.

6. Tangential section, ×50, exhibiting the microscopic wall structure.

Lower Cretaceous (Aptian): Faringdon, England.

FIGS. 7, 8. *Ceriopora dimorphocella*, new species ......................... 29

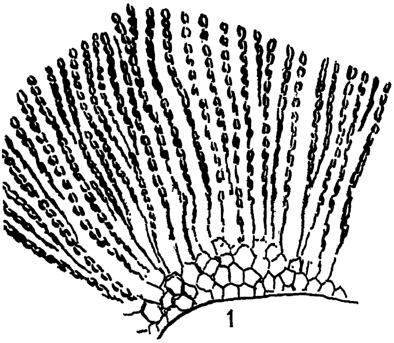
Tangential section, ×12 and ×25, illustrating the wall structure.

Lower Cretaceous (Aptian): Faringdon, England.

FIG. 9. *Clausa zonifera*, new species ..................................... 80

Tangential thin section, ×25.

Lower Cretaceous (Aptian): Faringdon, England.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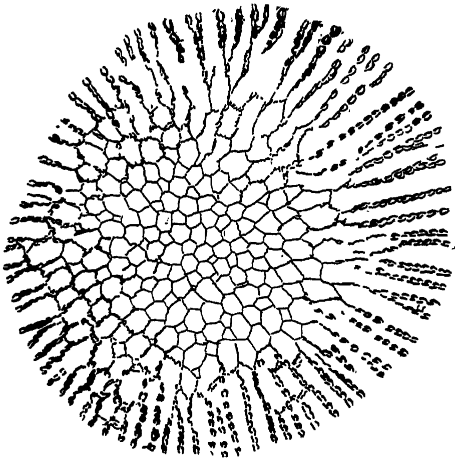
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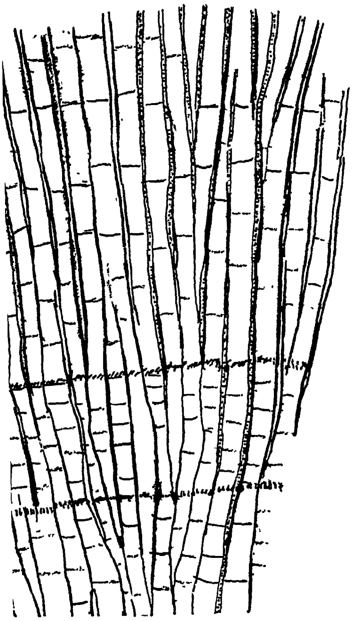
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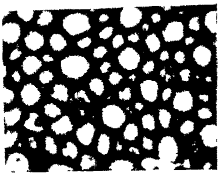
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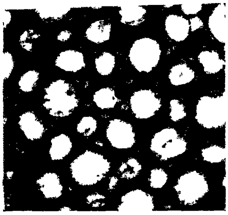
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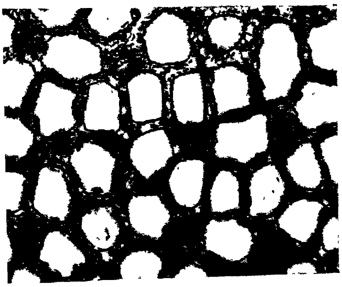
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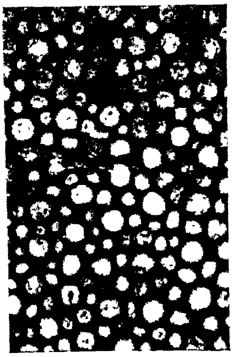
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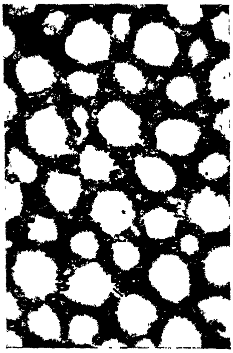

8

LOWER CRETACEOUS CYCLOSTOMATOUS BRYOZOA

FOR EXPLANATION OF PLATE SEE PAGE 124

# THREE NEW LAND SHELLS FROM MEXICO

BY PAUL BARTSCH

*Curator, Division of Mollusks, United States National Museum*

In a recent sending of land mollusks from Mexico, received from C. R. Orcutt, are three new Urocoptid land shells, which are here described.

### HOLOSPIRA (HOLOSPIRA) ORCUTTI, new species

Plate 1, figs. 5, 6

Shell large, cylindro-conic, flesh colored with a pinkish flush. The last half of the last turn marked with pale-brown, which is also the color of the base. Nuclear whorls 2.3, large, strongly rounded, smooth, forming an almost mammillate apex. Early postnuclear whorls increasing rapidly in size, marked by rather strongly decidedly retractively slanting threadlike riblets which are separated by spaces three and four times the width of the riblets. These riblets become evanescent on the sixth turn and on the whorls that follow there are mere indications of them. The last turn and a half is again ribbed and on the latter portion of the last whorl the riblets are almost lamellar. The early whorls are slightly over-hanging, while the rest are appressed at the summit. About one-tenth of the last turn is free at the summit, and the angle of the summit stands out markedly here. There is a subobsolete constriction where the side of the whorl meets the basal portion, the axial ribs extending over the base into the umbilical region. The umbilicus is rimate, but not open.

Aperture rather large with a very broad, thick, slightly reflected, wide, shining peristome. Interior of aperture pale-brown.

The type, Cat. No. 361960, U.S.N.M., has 14.5 whorls and measures: Altitude, 25.3 mm.; greater diameter, 8.4 mm. It was collected on a limestone paredon at Coahuila, Mexico.

Twenty-four additional specimens, Cat. No. 361961, U.S.N.M., paratypes, yield the following measurements:

| Number of whorls | Length | Diameter | Number of whorls | Length | Diameter |
|---|---|---|---|---|---|
| 14. 5* | 25. 3 | 8. 4 | 14. 5 | 25. 3 | 9. 0 |
| 14. 0 | 24. 9 | 8. 4 | 13. 5 | 26. 5 | 9. 8 |
| 13. 8 | 23. 5 | 8. 0 | 13. 5 | 23. 3 | 8. 0 |
| 13. 3 | 23. 3 | 8. 4 | 12. 8 | 22. 5 | 8. 9 |
| 14. 2 | 24. 7 | 8. 9 | 13. 0 | 21. 0 | 7. 8 |
| 13. 3 | 22. 1 | 8. 5 | 13. 3 | 22. 3 | 8. 4 |
| 14. 2 | 23. 8 | 8. 3 | 12. 4 | 20. 3 | 8. 1 |
| 13. 2 | 21. 3 | 8. 1 | 12. 6 | 20. 6 | 8. 3 |
| 14. 0 | 24. 8 | 8. 5 | 13. 3 | 22. 5 | 8. 8 |
| 13. 0 | 23. 8 | 9. 1 | 13. 8 | 24. 2 | 9. 2 |
| 14. 5 | 24. 7 | 8. 1 | 14. 0 | 23. 6 | 8. 0 |
| 14. 2 | 25. 1 | 8. 0 | 13. 3 | 21. 9 | 7. 9 |
| 14. 4 | 27. 9 | 9. 3 | | | |
| Greatest | | | 14. 5 | 27. 9 | 9. 8 |
| Least | | | 12. 4 | 20. 3 | 7. 8 |
| Average | | | 13. 62 | 23. 57 | 8. 49 |

*Type.

### HOLOSPIRA (HOLOSPIRA) MONCLOVANA, new species

Plate 1, figs. 1, 2

Shell acicular, bluish-white. Interior of aperture brown. Nuclear whorls 2½, rather large, well rounded, smooth. The postnuclear whorls are rather narrow. The first seven increase slowly in size and form a narrow cone. They are marked by numerous, slender, decidedly retractively slanting axial riblets, which are about one-third as wide as the spaces that separate them. These riblets grow successively weaker from the first to the seventh of these turns and on the succeeding whorls, which are moderately rounded, they are indicated at best only as lines of growth. The last whorl is marked by strong, somewhat irregular, curved axial ribs, which are about as wide as the spaces that separate them. Suture moderately impressed. Periphery of the last whorl marked by a rather strong carina. This carina is separated from the posterior portion of the whorl by a somewhat pinched-in zone. The last fifth of the whorl is free from the preceding turn at the summit and the angle of the summit forms a strong carina, while the space between it and the preceding turn, that is, the outside of the parietal wall, is flattened. Anterior to the peripheral carina the base slopes toward the umbilical chink, which is rimate but not perforate. This portion of the base is marked by rough lines of growth. Aperture broadly pear-shaped with the outer lip decidedly expanded, thickened, and reflected into a disjunct peristome.

The type, Cat. No. 361962, U.S.N.M., was collected at southeast Monclova, Coahuila, Mexico. It has 16.5 whorls and measures: Length, 20.9 mm.; diameter, 6.3 mm.

Cat. No. 361963, U.S.N.M., contains 24 additional specimens which yield the following measurements:

| Number of whorls | Length | Diameter | Number of whorls | Length | Diameter |
|---|---|---|---|---|---|
| 16. 5* | 20. 9 | 6. 3 | 15. 5 | 20. 1 | 6. 0 |
| 15. 0 | 19. 6 | 5. 9 | 15. 8 | 20. 3 | 5. 9 |
| 16. 7 | 21. 8 | 5. 9 | 15. 0 | 19. 4 | 5. 4 |
| 16. 7 | 22. 3 | 5. 9 | 14. 8 | 19. 2 | 5. 8 |
| 15. 3 | 20. 2 | 5. 9 | 14. 2 | 17. 9 | 5. 3 |
| 15. 8 | 20. 4 | 5. 8 | 15. 8 | 19. 7 | 5. 2 |
| 15. 0 | 19. 2 | 5. 8 | 15. 0 | 19. 0 | 5. 4 |
| 14. 4 | 18. 0 | 5. 6 | 15. 0 | 20. 0 | 5. 7 |
| 15. 2 | 20. 4 | 6. 0 | 15. 3 | 19. 6 | 5. 8 |
| 14. 0 | 18. 1 | 5. 8 | 16. 0 | 19. 6 | 5. 6 |
| 16. 3 | 21. 6 | 5. 4 | 15. 0 | 19. 2 | 5. 6 |
| 15. 4 | 20. 1 | 5. 9 | 14. 3 | 18. 4 | 5. 3 |
| 16. 7 | 20. 5 | 5. 4 | | | |
| Greatest | | | 16. 7 | 22. 3 | 6. 3 |
| Least | | | 14. 0 | 17. 9 | 5. 2 |
| Average | | | 15. 39 | 19. 8 | 5. 7 |

*Type.

### HOLOSPIRA (EUDISTEMMA) PICTA, new species

Plate 1, figs. 3, 4

Shell acicular, bluish-white, with a narrow zone of rusty-brown immediately below the summit. The area immediately behind the aperture is also very dark-brown, the basal portion being a little paler. Interior of aperture brown. Nuclear whorls 2.2, well rounded, with an indication of distantly spaced axial lines of growth which hint at a progressive state of sculpture; that is, the postnuclear sculpture is passing up on the nuclear turns. Postnuclear whorls narrow, the early ones well rounded, the later only moderately so, all appressed at the summit. The first four are marked by decidedly retractively curved, slender axial riblets which are about one-third as broad as the spaces that separate them. The riblets become increasingly less developed from the first to the last of these turns after which they become quite obsolete, so that the following turns are marked only by indications of lines of growth. However, on the last two and one-half turns we again have ribs appearing, but these ribs are large, broad, rough, and rather ill-defined. Suture moderately impressed. Periphery of the last turn, which is rather high, marked by a very strong carina with a pinched-in area immediately above and below it. The basal wall sloping to the umbilical chink is marked by numerous, rough, slightly lamellar ribs. There are here also some indications of spiral sculpture. Aperture moderately large, more or less triangular, with a broad, expanded and reflected, wide peristome which is free. The summit of the free portion of the last whorl forms a strong carina. The outside of the free portion of the parietal wall is marked by the continuation of the axial ribs.

The type, Cat. No. 361964, U.S.N.M., was collected east of Monclova, Coahuila, Mexico. It has 17 whorls and measures: Length 22.1 mm.; diameter, 5.3 mm.

Twenty-four additional specimens, Cat. No. 361965, U.S.N.M., yield the following measurements:

| Number of whorls | Length | Diameter | Number of whorls | Length | Diameter |
|---|---|---|---|---|---|
| 17.0* | 22.1 | 5.3 | 15.0 | 19.1 | 4.7 |
| 16.2 | 20.6 | 4.8 | 16.5 | 21.0 | 4.9 |
| 15.5 | 19.7 | 5.7 | 15.0 | 19.8 | 4.5 |
| 17.2 | 23.3 | 4.8 | 16.5 | 21.0 | 5.0 |
| 14.8 | 18.4 | 4.9 | 15.4 | 18.9 | 4.8 |
| 17.0 | 21.5 | 5.0 | 16.3 | 20.5 | 4.8 |
| 15.3 | 18.9 | 4.9 | 16.2 | 19.8 | 4.9 |
| 17.2 | 22.1 | 4.9 | 15.6 | 20.8 | 5.1 |
| 15.8 | 20.6 | 5.4 | 15.2 | 19.1 | 5.1 |
| 16.3 | 19.4 | 4.9 | 16.0 | 21.1 | 5.2 |
| 15.0 | 18.5 | 5.0 | 16.2 | 20.8 | 5.0 |
| 15.5 | 19.6 | 4.9 | 16.0 | 20.8 | 5.2 |
| 17.0 | 21.0 | 4.9 | | | |
| Greatest | | | 17.2 | 23.3 | 5.7 |
| Least | | | 14.8 | 18.5 | 4.5 |
| Average | | | 15.99 | 20.34 | 4.98 |

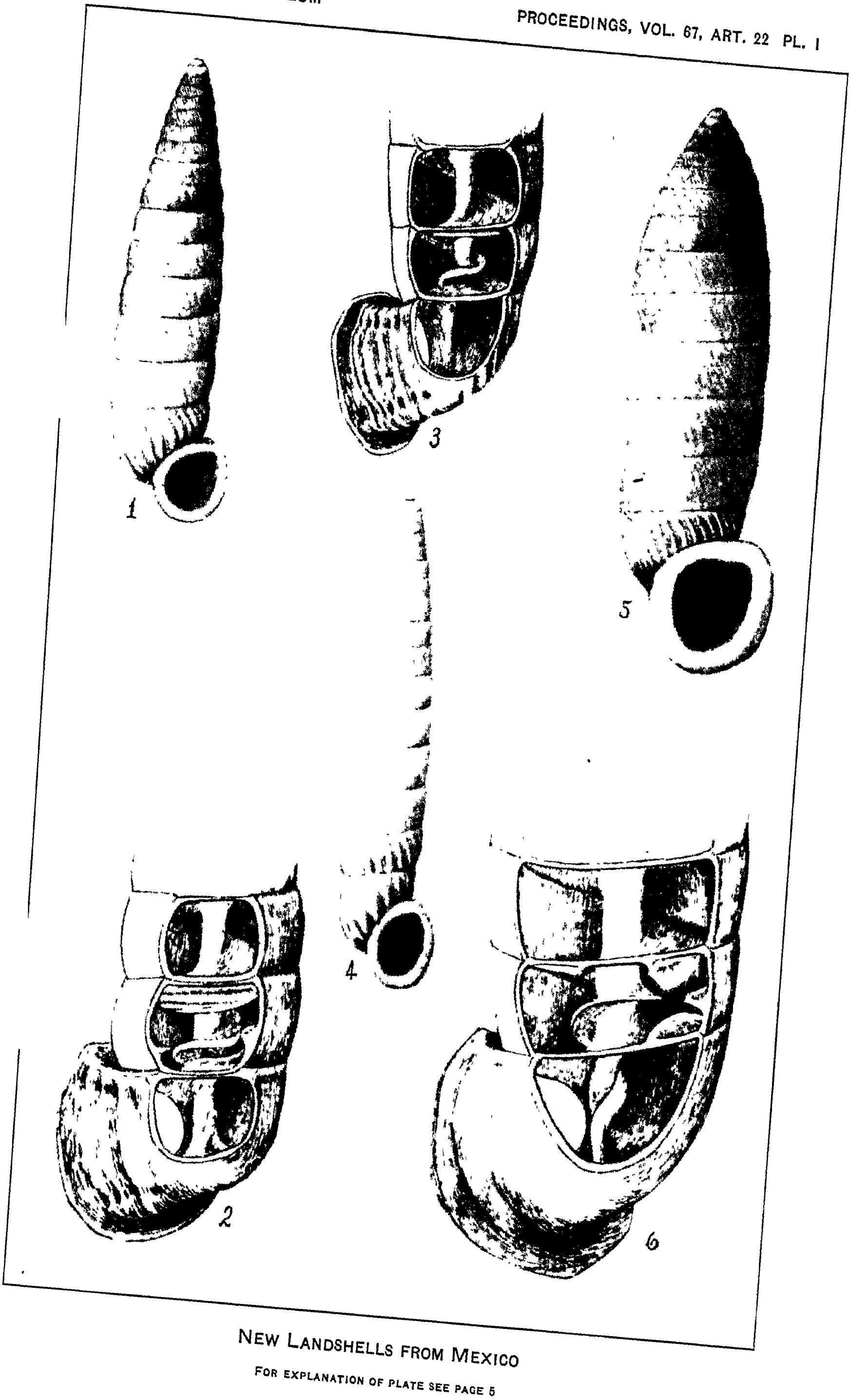
*Type.

Another lot, Cat. No. 361966, U.S.N.M., taken at an altitude of 3,000 feet, about halfway between Nueva Leon and Monclova, Coahuila, Mexico, appears to belong to this species. Twenty-four specimens of this lot yield the following measurements:

| Number of whorls | Length | Diameter | Number of whorls | Length | Diameter |
|---|---|---|---|---|---|
| 14.8 | 17.4 | 4.9 | 16.3 | 20.4 | 4.8 |
| 15.0 | 18.6 | 4.5 | 15.2 | 18.9 | 4.8 |
| 14.8 | 18.7 | 4.7 | 15.3 | 20.4 | 5.7 |
| 15.8 | 19.7 | 4.6 | 15.5 | 19.6 | 4.8 |
| 15.7 | 19.1 | 4.3 | 15.4 | 19.0 | 5.1 |
| 15.3 | 18.7 | 4.7 | 14.5 | 18.4 | 5.3 |
| 15.0 | 18.5 | 4.1 | 15.8 | 19.5 | 4.5 |
| 15.0 | 18.1 | 4.4 | 16.2 | 20.0 | 4.2 |
| 16.0 | 20.2 | 4.3 | 14.8 | 18.7 | 5.1 |
| 14.3 | 18.5 | 5.4 | 15.2 | 20.5 | 4.6 |
| 16.0 | 21.4 | 4.4 | 15.5 | 19.2 | 5.0 |
| 14.2 | 17.5 | 4.5 | 16.3 | 20.6 | 4.7 |
| Greatest | | | 16.3 | 21.4 | 5.7 |
| Least | | | 14.2 | 17.4 | 4.1 |
| Average | | | 15.32 | 19.23 | 4.72 |

## EXPLANATION OF PLATE

FIG. 1. *Holospira* (*Holospira*) *monclovana* B.
2. *Holospira* (*Holospira*) *monclovana*, showing internal lamellation.
3. *Holospira* (*Eudistemma*) *picta* B., showing internal lamellation.
4. *Holospira* (*Eudistemma*) *picta.*
5. *Holospira* (*Holospira*) *orcutti* B.
6. *Holospira* (*Holospira*) *orcutti*, showing internal lamellation.



NEW LANDSHELLS FROM MEXICO

FOR EXPLANATION OF PLATE SEE PAGE 5

# TEN NEW NORTH AMERICAN ICHNEUMON-FLIES

By R. A. Cushman

*Of the Bureau of Entomology, United States Department of Agriculture*

This paper consists of the descriptions of ten new species of Ichneumonidae, several of which are representatives of genera not previously recognized in the North American fauna.

## Genus NEOTYPUS (Foerster) Holmgren

No North American representative of this genus has heretofore been described. The following new species is typical of the genus.

### NEOTYPUS AMERICANUS, new species

*Male.*—Length, 7.5 mm.

Very similar to *melanocephalus* (Gmelin). As in the male of that species the claws are not pectinate. From the single male of *melanocephalus* available to me it differs practically only as follows: eyes shorter than width of vertex, the malar space and ocell-ocular line therefore longer, the former nearly half as long again as the basal width of mandible and the latter about twice as long as the diameter of a lateral ocellus; scutellum practically impunctate, polished, the carinae higher and more strongly converging posteriorly; median areas of propodeum narrower, the areola fully two-thirds as long medially as wide, the petiolar area about twice as long as broad, closely transversely striate; second tergite nearly twice as wide at apex as at base, gastrocoeli subquadrate, broader than the distance between them.

White markings of front and face narrower, clypeus only faintly pale at sides; abdominal markings also smaller; hind legs entirely black.

*Type-locality.*—Hocking county, Ohio.

*Type.*—Cat. No. 27679, U.S.N.M.

One male received from Prof. C. H. Kennedy of Ohio State University.

### NEOTYPUS LAPIDATOR (Fabricius)

A female from Oregon (C. F. Baker collection) apparently differs in no way from this European species.

## Genus ANISOBAS Wesmael

No American representative of this genus has heretofore been described. The first of the following two new species is typical of the genus, being very closely allied to the genotype, *Anisobas cingulatorius* (Gravenhorst). The second species is somewhat anomalous.

### ANISOBAS NEARCTICUS, new species

*Female.*—Length, 7.5 mm.

Differs from *cingulatorius* principally as follows: vertex arched above level of top of eyes; eyes as long as width of vertex (not longer as in *cingulatorius*), parallel within; malar space distinctly shorter than basal width of mandible; clypeal furrow represented by a broad, shallow impression; clypeus convex, the apex slightly concavely truncate; flagellum with 25 joints (31 in *cingulatorius*); propodeum apically and laterally more strongly rugose; areola constricted medially and there divided by two strong parallel rugae; apical carina very high at apex of middle lateral area (area dentipara); dorsal carinae of first tergite strong and extending well on to postpetiole, the latter with a median impression; second tergite barely half as broad at base as at apex; third tergite more than twice as wide at base as long.

Frontal white markings extending broadly on to face; scutellar white spot smaller; hind tibia red, broadly fuscous at apex; otherwise colored as *cingulatorius.*

*Type-locality.*—Mount Desert, Me. (Southwest Harbor.)

*Type.*—Cat. No. 27680, U.S.N.M.

One specimen collected by C. W. Johnson.

### ANISOBAS BICOLOR, new species

Differs from both *cingulatorius* (Gravenhorst) and *nearcticus* Cushman in its entirely black thorax and entirely red abdomen. Apparently not very closely related to any of the other European species.

*Female.*—Length, 9 mm.; antennae, 6 mm.

Head nearly as broad at temples as at eyes, in front view with cheeks strongly rounded; distinctly punctate, densely so on face, frons, vertex, and cheeks, sparsely so on temples and clypeus, the last apically polished and impunctate, broadly concavely sinuate truncate; mandibles distinctly bidentate, ventral tooth somewhat the shorter; malar space hardly as long as basal width of mandible; eyes slightly shorter than breadth of vertex, parallel within; antennae stout, flagellum tapering toward apex; with 31 joints. Thorax coarsely punctate, rather densely so on mesoscutum, scutellum, and pleurum, more or less striately so on pleurum, sparsely so on metapleurum; notauli and sternauli faintly indicated basally; scutellum broad, weakly concave above, precipitous apically, with carinae strong to beyond middle; propodeum rugose, basal lateral areas densely punctate, carinae very high, submucronate at apices of middle lateral areas, areola barely half as long medially as broad, its anterior margin straight, posterior margin concavely curved. Abdomen coarsely punctate, that portion beyond the first tergite fusiform and somewhat more than half as broad as long, first tergite rugose laterally, post petiole punctate laterally, shining and more or less coriaceous medially, with dorsal carinae extending beyond spiracles; gastrocoeli deep, rugose.

Head and thorax black, abdomen entirely ferruginous; small lines on upper posterior orbits; antennae and palpi black; wings fusco-hyaline with dark venation; legs ferruginous, coxae and trochanters black, hind tibia at apex and tarsus fuscous, front tibia with a white stripe anteriorly from base to apex.

*Male.*—Differs from female in addition to the more slender abdomen principally as follows: eyes slightly longer than breadth of vertex; antennae (incomplete); scutellum flattened above, the carinae reaching to apex; areola hardly half as long medially as broad; postpetiole medially opaque coriaceous. In addition to the posterior orbital markings there is a small white spot on the inner orbits at top of face; legs, except ferruginous hind femur and apices of front and middle femora and the white stripe on front tibia, black.

*Type-locality.*—Lolo Trail, Bitter Root Mountains, Idaho.

*Allotype-locality.*—Cedar Mountain, Moscow, Idaho.

*Type.*—Cat. No. 27681, U.S.N.M.

Three females, the type taken by C. V. Piper in July, 1902; one taken at Olympia, Wash., June 2, 1897; and one from Santa Cruz Mountains, Calif.; and one male (the allotype) taken June 24, 1920, by M. C. Lane.

Both paratype females have small white markings on the humeral angles of the pronotum, and the California specimen has small spots also on the frontal orbits. The latter also has the postpetiole as in the male.

## Genus APAELETICUS Wesmael

This genus has not heretofore been recognized in the North American fauna, though Bradley [1] has somewhat doubtfully referred to it *Platylabus thoracicus* Cresson, *erythropygus* Provancher, and *quadricarinatus* Provancher which he excluded from *Platylabus* because of their circular propodeal spiracles. This character is too variable in the genus to exclude the three species from *Platylabus*, to which they are hereby restored. Moreover, they lack the very peculiar female abdominal conformation so characteristic of *Apaeleticus*.

The following new species appears to be a true *Apaeleticus*.

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[1] Can. Ent., vol. 35, 1903, p. 275.

### APAELETICUS AMERICANUS, new species

*Female.*—Length, 9 mm.; antennae, 8 mm.

Head from above transversely oval, the temples strongly narrowed, from in front subtriangular, the cheeks straight and strongly convergent; vertex and temples shining, punctate; frons transversely punctato-rugose; face medially elevated and sparsely punctate, laterally obliquely rugoso-punctate; clypeus convex, apically rounded and medially subtruncate, sparsely punctate; labrum narrowly exserted; malar space much longer than basal width of mandible; mandibles subfalcate, narrow at apex, the lower tooth very small and far from apex; eyes large, bulging, entire within; antennae slender, apically attenuate; macillary palpi long, slender, second joint triangular. Pronotum punctate above, polished and without sculpture below, with a few rugae along posterior margin; propleurum flat and densely punctate below and carinately margined on each side; mesoscutum evenly punctate, the punctures distinctly separated, notauli distinct but very short; scutellum elevated, sparsely punctate, margined to beyond middle, the carinae very strong to above bases of wings; mesopleurum and metapleurum rugoso-punctate, speculum polished, sternauli strong; propodeum coarsely reticulate-rugose, this sculpture largely obscuring the carinae, apophyses strong, spiracles small, oval; areolet irregularly pentagonal; nervellus reclivous, broken below middle; nervulus interstitial. Abdomen narrow fusiform, truncate at apex of fifth tergite, the apical tergites being hidden within the fifth; petiole rather slender, without dorsal carinae, postpetiole moderately broad, polished except in apical corners, where it is punctate; other visible tergites, except fifth, densely punctate, gastrocoeli broad, shallow, opaque, lunulae distinct on second and third.

Ferruginous; antennal annulus, collar medially, scutellum and minute spots on subalar tubercles yellow; pedicel, flagellum beyond second joint, mandiples, palpi, margins of propleura, tegulae, sutures in scutellar and alar regions, mesosternum posteriorly, metasternum, and apices of hind femur and tibia blackish; wings hyaline.

*Type-locality.*—Cabin John, Md.

*Type.*—Cat. No. 27682, U.S.N.M.

Two females, the type, taken September 7, 1916, by R. M. Fouts; the paratype taken on the summit of Mount Katahdin, Me., at an elevation of 5,215 feet, in August, 1902, has the sculpture somewhat stronger throughout, the postpetiole medially rugulose, and the clypeus and scrobes of pronotum piceous.

### Genus POLYCYRTUS Spinola

Although it is not uncommon in the vicinity of Washington and has been represented in the National Collection for many years, the fact that the following new species has not been described appears to have been overlooked. This is the more strange considering that it is apparently the only species referable to the genus to be found in the Atlantic States at least so far north.

### POLYCYRTUS NEGLECTUS, new species

*Female.*—Length, 11.5 mm.; antennae, 9 mm.

Head polished with a few coarse punctures on face and in ocellar space; temples sharply convexly sloping; ocell-occipital line nearly twice as long as diameter of an ocellus; frontal horn stout, nearly as thick at base as long; malar space finely shagreened; three-fourths as long as basal width of mandible; head not constricted below eyes, extended angle[2] of cheeks in front view slightly less than a right angle; eyes very slightly convergent below. Thorax polished; pronotum with scrobes obliquely striate; mesoscutum anteriorly, pleurum below, and sternum sparsely and coarsely punctate, pleurum with a small obliquely rugose area behind upper end of prepectal carina; metapleurum more densely punctate, vertically rugose posteriorly; propodeum polished, sparsely punctate medially and laterally, longitudinally rugose near apex; apophyses about as long as thickness of petiole; areolet rather large, about two-thirds as wide as long, recurrent near apex; nervulus antefurcal. Abdomen shinging, more or less distinctly and very finely shagreened; first tergite polished, postpetiole gibbous above with a deep dimplelike fovea on each side above spiracle; ovipositor sheath as long as first two tergites.

Black and flavous or whitish, thorax laterally and ventrally tinged with testaceous; head pale except the occiput and a broad band extending from occiput over vertex to base of antennae, broadened on upper temples, apices of clypeus and mandibles, articulations of latter, and a short narrow line between antennae; antennae black with a white annulus embracing flagellar joints 6–9 and part of 5, 10, and 11; palpi white basally, testaceous apically. Thorax dorsally black with the following pale markings: Anterior margin and humeral welts of pronotum, two elongate marks on disk of mesoscutum, tegulae, scutellar carinae, and apices of scutellum and postscutellum with lines along the sutures to bases of wings; laterally and ventrally pale testaceous to stramineous, black above and below subalar tubercle, and with small brownish spots in mesopleural fovea and near apex of mesopleurum; propodeum with three longitudinal black stripes, the lateral ones beginning with and encircling the spiracles and extending along pleural carinae nearly to apex, the median one extending from a narrow basal black band to apex and abruptly broadened along the basal carina; legs pale testaceous to stramineous, the hind tarsi distinctly paler; wings hyaline, veins dark, stigma pale. First tergite with a median black stripe, broadened on postpetiole, not reaching apex; second tergite black with the apex broadly and a lunate mark on each side nearly surrounding the spiracle pale, the apical band partly interrupted on each side by an abrupt offshoot from the black; third tergite black basally, pale apically, with a pale spiracular spot; fourth to seventh black basally, pale apically, more broadly so at sides; eighth black medially pale laterally.

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[2] The angle formed by lines having the same direction as the cheeks in relation to each other.

*Male.*—Like female, but with sculpture stronger, antennal annulus embracing flagellar joints 9–16; first abdominal segment black ventrally, and coxae paler above with a narrow blackish line.

*Type-locality.*—Cabin John, Md.

*Type.*—Cat. No. 27683, U.S.N.M.

Described from 11 females and 16 males; the type taken by G. N. Collins; 3 other females and 2 males from the type-locality (R. M. Fouts); 1 male, Chain Bridge, Va. (W. Middleton); 1 female, Rosslyn, Va. (H. H. Smith); 1 male (allotype), Falls Church, Va. (Frederick Knab); 1 female, Glencarlyn, Va. (S. A. Rohwer); 1 male, Dixie Landing, Va.; 1 female, Virginia; 1 male, Washington, D. C. (R. M. Fouts); 1 male, District of Columbia; 1 female, Coosa River, Chilton county, Ala. (H. H. Smith); 1 female, Coleta, Ala. (H. H. Smith); 1 female and 4 males, Pysiton, Clay county, Ala. (H. H. Smith); 1 male, Longdale, Chambers county, Ala. (H. H. Smith); 3 males, Paradise Key, Fla. (C. A. Mosier); 1 female, Blount county, Tenn.; and 1 female, Dallas, Tex. (F. C. Bishopp).

This series shows considerable variation. The type is about average in size, the variation being about two millimeters in each direction. The sculpture of the apical slope of the propodeum varies from nearly smooth to mostly rugose, with sometimes a rather distinctly defined narrow median longitudinal area. Some of the females have the petiole black beneath as in the allotype, while many of the males lack the spiracular white spot on the third tergite.

### Genus **BRACHYCRYPTUS** Thomson

The species described below is not entirely typical of the genus, differing from Thomson's description as follows: mesoscutum rather strongly declivous anteriorly; nervellus reclivous, broken at or above the middle; hind tibia distinctly longer than femur; pulvilli small. It is also considerably larger than either of Thomson's three species, though smaller than *simplex* (Tschek), which was subsequently referred to the genus by Schmiedeknecht; and has the abdomen red only narrowly at the apices of the first two tergites. If it does not belong to this genus it can not be referred to any described genus and I prefer to place it here rather than add to an already too long list of almost meaningless generic groups.

### BRACHYCRYPTUS NIGER, new species

*Female.*—Length 7.5 mm.; antennae 5 mm.

Temples very strongly narrowed, slightly convex, sparsely and finely punctate, polished; eyes very large, bulging, convergent below; face about two-thirds as broad as top of frons, opaque, finely and densely punctate; clypeus more coarsely sculptured than the face, transversely rugoso-punctate, very narrowly margined and arcuate at apex; malar space slightly more than half as long as basal width of mandible; upper tooth of mandible slightly longer than lower; frons opaque laterally, shinging medially, with distinct polished scrobes; ocelli small, the diameter of a lateral ocellus shorter than ocell-ocular line and little more than half as long as postocellar line; antennae filiform, flagellum of uniform thickness throughout, first two joints elongate and equal in length. Thorax: pronotum punctate above, obliquely striate in middle, polished in lower angle; mesoscutum shining, sparsely punctate, declivous anteriorly, notauli sharp, narrow, minutely foveolate, reaching nearly to middle; scutellum convex, shining and sparsely punctate basally, longitudinally striato-punctate apically, carinae distinct to middle; mesopleurum and sternum and metapleurum opaque punctate, the mesopleurum shining and more sparsely punctate above and polished in upper posterior corner, sternauli short and broad; propodeum opaque punctate, basal lateral areas shining and sparsely punctate, basal carina only slightly curved, apical carina narrowly separated from it medially, with short carinate apophyses, petiolar area very broad and flat; aerolet almost regularly pentagonal; discocubitus unbroken; nervellus broken at the middle, reclivous; legs long, slender, hind tibia slightly longer than femur, basitarsus very nearly as long as other joints combined, pulvillus very small. Abdomen subclavate; first tergite longer than second, very slender, flattened above, polished, postpetiole about twice as wide as petiole, slightly decurved, with a distinct longitudinal impression between the spiracles; abdomen otherwise very finely granularly opaque, second tergite nearly as broad as long and more than twice as broad at apex as at base, gastrocoeli very small, spiracles far beyond middle and close to margin; sheath shorter than first tergite.

Black; first and second tergites narrowly reddish apically; apex of abdomen with a white spot beginning on sixth tergite; wings hyaline, venation black; front legs beyond trochanters and middle and hind femora except at apex testaceous, legs otherwise black to piceous.

*Male.*—Differs from female as follows: temples less strongly narrowed and more strongly convex; face only slightly narrower than frons; molar space nearly as long as basal width of mandible; antennae slightly tapering apically; thorax dorsally more strongly and densely punctate; nervellus broken distinctly above middle; hind tibia much longer than femur, basitarsus barely as long as next three joints; abdomen narrower, second tergite much longer than broad at apex; abdomen apically immaculate; apical joints of all trochanters testaceous.

*Type-locality.*—Ohio.

*Type.*—Cat. No. 27684, U.S.N.M.

One of each sex received from Prof. C. H. Kennedy of Ohio State University.

### Genus SYZEUCTUS Foerster

Foerster, Ashmead, and Schmiedeknecht all employ as one of the key characters ascribed to this genus the lack of a carina separating metapleurum and propodeum. As a matter of fact, the genotype, *maculatorius* (Fabricius), frequently has a more or less developed carina, while the two species described below have it well developed. The only real difference between the present genus and its nearest relative, *Diceratops* Foerster, lies in the frontal horns of the latter.

### SYZEUCTUS SIGMOIDALIS, new species

Especially remarkable for the peculiar nervellus.

*Female.*—Length, 9 mm.; antennae, 7.5 mm.; ovipositor, 6.5 mm.

Head transversely oval, temples convexly sloping; postvertex (that portion of the head lying between the ocelli and the occipital carina) medially impressed, polished with a few scattered punctures; temples with more numerous punctures, running into fine shagreening on cheeks; vertex and frons more densely punctate, the latter medially slightly concave; aface similarly punctate, strongly convex, with a rather deep impression on each side just below level of antennae; clypeus separated from face by a broad deep groove; polished with few punctures; malar space nearly as long as basal width of mandible. Thorax and prododeum with coarse and dense but distinct punctures, finer and closer on prescutum, coarsest on propodeum; apical and pleural carinae complete; nervellus a sigmoid curve, more strongly curved below where it turns backward and is apparently continuous with the obsolete discoidella; hind tibia about one and one-half times as long as femur, basitarsus as long as three following joints. Abdomen minutely and faintly shagreened and sparsely and finely punctate, broadly polished; first tergite two-thirds as broad at apex as long, sides straight, spiracles at basal third; tergites 2–4 as long as broad at base, others successively rapidly shorter.

Black with abdomen partly red; upper anterior and posterior orbits, broad on frons and narrowly confluent on apex, clypeus at apex, and spot on base of mandible yellow; antennae black basally and above, brown beneath nearly to base of flagellum; palpi brownish testaceous. Thorax immaculate; tegulae piceous; wings hyaline, veins dark stigma and costa pale; legs testaceous, coxae and trochanters black, tibiae yellow at base, hind tibia at apex and tarsus fuscous, basitarsus pale in middle. First tergite black at base, rufous at apex; tergites 2 and 3 and basal middle of 4 rufous, 2 and 3 with narrow black lines extending backward from spiracles; apex of abdomen black.

*Male.*—In structure and color much like female but differing markedly in color as follows: entire face, malar space, lower cheeks, orbits except a very narrow interruption on cheek, mandibles, scape and pedicel beneath, propleura, triangular spots at origins of notauli, spots on pronotum immediately below these, scutellum laterally, postscutellum, tegula, spot below, another spot lower on mesopleurum, and an irregular elongate spot before middle coxa yellow; front and middle coxae except at base behind, their trochanters, a large spot on upper outerside of hind coxae toward apex and a smaller one on the upper inner side, apical joint of hind trochanter, front and middle legs otherwise except testaceous streak on upper side of femora and blackish apical joint of middle tarsus, basal half or more of hind tibia and its tarsus largely yellow to stramineous; hind femur piceous; first tergite black except a narrow piceous apical margin in which are two small transverse yellow spots; second and fourth tergites red medially black laterally, third entirely red except black spiracular streaks, tergites beyond fourth entirely black.

*Type-locality.*—Godbout, Quebec.

*Type.*—Cat. No. 27685, U.S.N.M.

Described from nine females and six males all taken at the type-locality by E. M. Walker on July 25, 1918.

The only variations of moment are in the extent of the yellow markings in the male; the yellow spots on postscutellum, first tergite and the inner one on the hind coxae sometimes wanting and the first tergite entirely black. In other specimens these markings as well as the others are larger than in the allotype.

### SYZEUCTUS EPISCHNIAE, new species

*Female.*—Length, 8 mm.; antennae (broken); ovipositor, 7.5 mm. Temples straight, sloping to the rather broad occiput; polished and practically impunctate; cheeks convex, sparsely punctate, finely shagreened below; frons impressed and polished below, slightly swollen and punctate above and at sides; face strongly convex and punctate, with a small, deep impression on each side above; clypeus weakly separated, strongly convex, sparsely punctate; malar space nearly as long as basal width of mandible. Thorax and propodeum coarsely, evenly, and rather densely punctate, the punctures finer and closer on prescutum; apical and pleural carinae of propodeum strong; nervellus normal, discoidella at lower third, the latter weak but complete; hind tibia hardly a third longer than femur; basitarsus as long as three following joints. Abdomen faintly shagreened and sparsely and finely punctate; first tergite polished, three-fifths as wide at apex as long, second three-fourths, third nearly, fourth fully as wide at base as long, others much shorter, the apical three retracted within fifth.

Black with abdomen largely red; head and thorax with yellow markings as follows: Orbits, broad in front and narrow behind eyes; malar space; face except a median black point above and a curved black line on each side from base of antenna to clypeal fovea; mandibles; triangular spots at origins of notauli; base of tegula; subalar tubercle; and scutellum laterally and apically; antennae black, brownish beneath; wings suffused brownish hyaline, veins dark, stigma and costa pale; legs testaceous to stramineous, hind coxae and basal joint of trochanter except at apex, middle coxa at base and behind, basal joint of trochanter behind, and front coxa at base black; abdomen, except extreme base of first tergite and the retracted apical joints, which are piceous, ferruginous.

*Male.*—In structure and sculpture like female, except that the abdomen is somewhat more slender with apical tergite not retracted; face entirely, cheeks, antennae beneath, propleura, a small spot near upper margin of pronotum, a long oblique streak on mesopleurum extending from middle coxa to anterior margin; a median spot on mesoscutum, postscutellum, a large spot apically on metapleurum, and a narrow subapical band on first tergite also yellow; front and middle legs, except extreme base of coxae, entirely yellow; hind coxa above below and at apex, basal joint of trochanter apically and apical joint entirely, base and apex of femur, tibia except its fuscous apex, and tarsus largely yellow; hind femur piceous with a paler streak above; first tergite, except as noted above, and apex of abdomen black.

Host.—*Epischnia granitella* Ragonot.

*Type-locality.*—Crows Landing, Calif.

*Type.*—Cat. No. 27686, U.S.N.M.

One female and two males reared from the host during December, 1911, and January, 1912, by F. A. Hyde, under Chittenden No. $2109^{03}$.

The paratype male is less extensively yellow than the allotype, lacking the discal mesoscutal spot and those on postscutellum and metapleurum, while the mesopleural spot is represented by an irregular streak in front of the middle coxa and a very small spot near anterior margin, and the submarginal band on first tergite is interrupted medially.

### Genus CAMPOPLEX Gravenhorst

The new species described below runs in Schmiedeknecht's key[3] to couplet 30 where it agrees with all of the characters assigned to *Eulimneria* Schmiedeknecht except that the head is not broad behind the eyes. Beyond this point it runs to *Idechthis* Foerster. Both *Eulimneria* and *Idechthis* I consider as synonyms of *Campoplex* Gravenhorst.

#### CAMPOPLEX DIGITATUS new species

*Female.*—Length 6.5 mm.; antennae, 5 mm.; ovipositor, 0.8 mm. Head transverse with temples convexly sloping, in front view slightly transversely oval; face slightly narrower than frons; eyes shallowly emarginate opposite antennae; face and clypeus opaque, finely, densely punctuate; malar space hardly half width of mandible; ocell-ocular line, ocellar diameter, and postocellar line in the proportion of 1:1.5:2; flagellum rather stout, tapering at apex. Thorax stout ovoid, granularly opaque, speculum not at all polished; propodeum dull, rugulosely roughened, areola and petiolar areas confluent, broad, concave, costulae distinct; stigma about a fourth as wide as long, areolet petiolate, recurrent near apex, external angle of second discoidal cell acute, nervulus postfurcal, postnervulus broken at about the middle, nervellus curved but not broken, reclivous; longer hind calcarium a little more than two-thirds as long as basitarsus; basitarsus as long as rest of tarsus, apical joint hardly longer than fourth, claws pectinate. Abdomen very minutely granularly opaque, more or less punctate toward base; first tergite stout, the postpetiole broad and strongly convex, petiole laterally foveate at base of postpetiole; second tergite one and two-thirds times as long as broad at base, spiracles beyond middle, gastracoeli shallow but distinct, removed from base; ovipositor sheath much shorter than first tergite, ovipositor upcurved.

Black with basal three tergites more or less reddish toward apex; mandibles, palpi, tegulae and wing bases white; antennae black, scape red beneath; wings hyaline, venation dark, stigma paler; front legs stramineous except the pale testaceous femur; hind coxa, basal joint of trochanter and femur testaceous, apical joint of trochanter stramineous, tibia with apical third and a narrow subbasal annulus black, the rest white, tarsi black with basitarsus broadly and other joints very narrowly white at base; middle leg like front leg except that the tibia and tarsus have the pattern of those of the hind leg repeated in pale testaceous and white.

*Male.*—Like female but ocelli larger, the ocell-ocular line, ocellar diameter, and postocellar line ratio being 1:2:2; the abdomen narrower and entirely black; and the legs with more white.

*Type-locality.*—Newington, N. H.

*Type.*—Cat. No. 27687, U.S.N.M.

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[3] Opusc. Ichn., pp. 1521-1529.

Ten females and one male reared from tortricids at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.; the type under No. 6988G, host unknown; the allotype and four paratypes under No. 12157C, from Westerly, R. I., host *Gelechia trialbamaculella* Chambers or (*Oletheureutes*) *Peronea permutana* Duponche; five paratypes under No. 12101B, from Maynard, Mass., host *Acrobasis caryaevorella* Ragonot.

The paratypes show some variation especially in the amount of white on the hind legs and of red on the abdomen, the latter being sometimes entirely black.

The cocoon of the type is mounted with the specimen. It is cylindrico-ovate, 6.5 mm. long by 2.5 mm. thick, white with irregular blotches of dark brown at each end and a row of blotches on each side of middle.

## Genus CREMASTUS Gravenhorst

### CREMASTUS (CREMASTUS) SINUATUS, new species

Very distinct from all other species known to be in the peculiar form of the ovipositor, which is sinuate at the apex nearly as in *Pristomerus*.

In my key to the North American species of *Cremastus*[4] it runs nowhere satisfactorily. Specimens with the thorax strongly marked with black run perhaps best to *decoratus* Gravenhorst but have the thorax more yellow and the abdomen more red. Those in which the black is largely replaced by reddish run better to couplet 7 where they agree with neither alternate.

*Female.*—Length, 12 mm.; antennae, 6.5 mm.; ovipositor, 5 mm.

Head from above very strongly transverse, temples convex near eyes, thence nearly flat and nearly perpendicular to body axis; head from in front distinctly broader than long; face as broad as length of eye and slightly broader than frons, medially slightly convex and densely punctate, laterally shagreened and sparsely punctate; clypeus two-thirds as long as interfoveal line, strongly convex, apically rounded, sparsely and coarsely punctate; malar space three-fourths basal width of mandible; diameter of lateral ocellus slightly longer than ocell-ocular line, three-fourths postocellar line. Thorax moderately long, with coarse, well separated punctures, the pronotal furrow and the speculum polished, scutellum sparsely punctate, rather flattened, with lateral carinae strong at base but terminating abruptly just beyond; propodeum extending slighlty beyond middle of coxae, in profile strongly arched, opaque shagreened, coarsely and sparsely punctured and medially, especially in petiolar area, transversely rugose, areola only a little longer than broad, two-thirds as long as petiolar area, from which it is distinctly separated; stigma nearly half as broad as long with radius slightly beyond middle; subdiscoideus above upper third of postnervulus. Abdomen long and slender, distinctly compressed from apex of second tergite; first tergite longer than median length of propodeum and than second tergite, ventral margins approximate, lateral carinae obsolete, postpetiole hardly twice as wide as petiole, second tergite about five times as long as broad at base, longitudinally striate; ovipositor straight, slender, sinuate at apex.

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[4] Proc. U. S. Nat. Mus., vol. 53, 1917, pp. 511–516.

Head and thorax yellow with black markings as follows: stemmaticum, frons, occiput, pronotal grooves, middle of each lobe of mesoscutum, prescutellar fovea, area around scutellum and wing bases, postscutellum, propodeum medially, upper part of mesopleurum and metapleurum below, mesosternum except a small yellow spot on each side of middle behind, a small spot just above position of sternaulus on mesopleurum, metasternum, and prepectus medially; legs testaceous, front and middle ones more stramineous, coxae and trochanters yellow, the coxae more or less black basally; wings hyaline, venation dark; abdomen red, petiole, second tergite except at apex and third basally blackish; sheath black.

*Male.*—Eyes and ocelli larger than in female, the eye length distinctly longer than width of face; diameter of ocellus fully as long as postocellar line and twice as long as ocell-ocular line, malar space little more than half as long as basal width of mandible; black markings of mesoscutum replaced by reddish and those of sternum by brown and reduced in extent; pronotum and upper part of mesopleurum nearly immaculate. The abdomen has been eaten away at apex and ventrally by dermestids.

*Type-locality.*—Coachella Valley, Calif.

*Allotype-locality.*—Presidio, Tex.

*Type.*—Cat. No. 27688, U.S.N.M.

Five females and one male all reared by Alan P. Dodd, of the Prickly Pear Board of Australia from lepidopterous larvae boring in *Opuntia.*

All but one of the specimens were reared as parasites of *Cactobrosis strigalis* Barnes and McDunnough, Paratype *b* having parasitized *Zophodia glaucatella* Hulst. Paratype *a* is from the allotype-locality, Paratype *b* from Uvalde, Texas, and the other two, which are returned to Mr. Dodd, are from the type-locality.

Paratype *a* and the two returned to Mr. Dodd are essentially like the type while Paratype *b* is even less extensively and less distinctly marked than the allotype.

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# SOUTH AMERICAN SNAKES IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

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During the course of a study which I have undertaken on the collection of South American snakes contained in the United States National Museum, I found several new forms that I have already described elsewhere[1] and a great many other species which are so interesting as to deserve a detailed description of their characteristics.

The examination of that collection has led me also to review a few important and complicated questions in systematics such as that concerning the real status of the two species of Elapidae, *Micrurus corallinus* (Wied, 1820) and *M. lemniscatus* (Linnaeus, 1758), as well as that of the species of Colubridae Dipsadinae *Sibynomorphus mikanii* (Schlegel, 1837).

In discussing the different specimens I shall confine myself to those characteristics which I have found to be different either from those of the type or from those ascribed to them by Boulenger in his "Catalogue of the Snakes in the British Museum."

I wish to express my gratitude to Dr. L. Stejneger for having permitted me to study the collection and also to Miss D. Cochran for placing every available facility at my disposal, as well as to Dr. Thomas Barbour for providing the opportunity of examining comparatively the collection of South American snakes in the Museum of Comparative Zoölogy.

### 1. HELMINTHOPHIS BONDENSIS Griffin

*Helminthophis bondensis* Griffin, Mem. Carnegie Mus., vol. 7, 1915, p. 165.

Colombia.—1 specimen, No. 61,675.

Panama.—3 specimens, Nos. 37009, 60517, and 61989.

### 2. EPICRATES CRASSUS Cope

*Epicrates crassus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 349.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 593.

Brazil.—1 specimen, type, No. 12413, from Paraná River.

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[1] Journ. Washington Acad. Sci., vol. 14, no. 9, 1924, pp. 200–202.

### 3. HELICOPS ANGULATA (Linnaeus)

*Coluber angulatus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 217.
*Helicops angulatus* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 746.—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 278.

Dutch Guiana.—5 specimens: Nos. 11126 collected by Dr. Wyman and Nos. 11148, 11159, 12552, and 12553 collected by C. J. Hering.

Brazil.—1 specimen, No. 28946, collected in the Lower Amazon by Mr. Steere.

### 4. HELICOPS POLYLEPIS Guenther

*Helicops polylepis* GUENTHER, Ann. Mag. Nat. Hist., ser. 3, vol. 7, 1861, p. 426.—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 280.

Colombia.—1 specimen, No. 11274, collected at Madina (?) River by Dr. Ruth.

### 5. TETRANORHINUS NIGROLUTEUS Cope

*Tetranorhinus nigroluteus* COPE, Proc. Acad. Nat. Sci., Philadelphia, 1861, p. 298.—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 282.

Panama.—1 specimen, No. 65874.

### 6. TETRANORHINUS MOCQUARDI Bocourt

*Tetranorhinus mocquardi* BOCOURT, Le Naturaliste, 1891, p. 122.

Panama.—1 specimen, No. 54203.

### 7. NINIA[1] ATRATA (Hallowell)

*Coluber atratus* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, 1845, p. 245.
*Ninia atrata* COPE, Proc. Acad. Nat. Sci., Philadelphia, 1860, p. 340.
*Streptophorus atratus* BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 293.

Panama.—1 specimen, No. 64987.

### 8. DRYMOBIUS BIFOSSATUS (Raddi)

*Coluber bifossatus* RADDI, Mem. Soc. Ital. Modena, vol. 18, 1820, p. 333.
*Drymobius bifossatus* BOULENGER, Ann. Mag. Nat. Hist., ser. 6, vol. 12, 1894, p. 346; Cat. Snakes Brit. Mus., vol. 2, 1894, p. 10.

Paraguay.—1 specimen, No. 12401, collected by the Paraguay Expedition.

### 9. DRYMOBIUS BODDAERTII (Sentzen)

*Coluber boddaertii* SENTZEN, Meyer's Zool. Arch., vol. 2, 1796, p. 59.
*Drymobius boddaertii* COPE, Proc. Acad. Nat. Sci., Philadelphia, 1860, p. 561.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 11.

Ecuador.—7 specimens: No. 14028, collected by W. J. Jones; No. 32040, collected by Mr. Stuart; and Nos. 62803–7, collected by F. W. Goding.

Venezuela.—2 specimens, No. 16831 collected in Caracas, by R. M. Bartheman, and No. 55335, collected by Mr. Musée.

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[1] The generic name *Ninia* Baird and Girard takes precedence, as it was published earlier (January) in the same year (1853) as *Streptophorus* Duméril and Bibron.

Dutch Guiana.—1 specimen, No. 11155, collected by Mr. C. J. Hering.

### 10. DRYMOBIUS RHOMBIFER (Guenther)

*Coryphodon rhombifer* Guenther, Proc. Zool. Soc. London, 1860, p. 236.

*Drymobius rhombifer* Bocourt, Miss. Sci. Mexique, Rept., 1888, pl. 43, fig. 1.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1894, p. 14.

Ecuador.—3 specimens, No. 12214 (2 specimens; larger—c. 103, anal entire; smaller—c. 94, anal divided), collected in Guayaquil, and No. 14022 collected by W. H. Jones.

### 11. DRYMOBIUS DENDROPHIS (Schlegel)

*Herpetodryas dendrophis* Schlegel, Phys. Serp., vol. 2, 1837, p. 196; Abbild., 1844, p. 132, pl. 44, figs. 25–28.

*Drymobius dendrophis* Cope, Proc. Acad. Nat. Sci, Philadelphia, 1860, p. 561.—Boulenger, Cat. Snakes, Brit. Mus., vol. 2, 1894, p. 15.

Ecuador.—3 specimens, No. 12268 (2 specimens) collected in Guayaquil and No. 14026 collected by W. H. Jones.

### 12. SPILOTES PULLATUS (Linnaeus)

*Coluber pullatus* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 225.

*Spilotes pullatus* Wagler, Syst. Amph., 1830, p. 179.—Boulenger, Cat. Snakes, Brit. Mus., vol. 2, 1894, p. 23.—Sternfeld, Senckenbergiana, 1920, p. 182.

*Spilotes megalolepis* Guenther, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 93.

*Spilotes microlepis* Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 346.

Panama.—1 specimen, No. 65857, collected at Fort Randolph, Canal Zone in August, 1921.

Brazil.—1 specimen, No. 39064, sent as *Phrynonax sulfureus* by Dr. V. Brazil, from Butantan, in Oct., 1909, and collected in Pirapitinguy, Sao Paulo.

### 13. DRYMARCHON CORAIS CORAIS (Boie)

*Coluber corais* Boie, Isis, 1827, p. 537.

*Drymarchon corais* Fitzinger, Syst. Rept., 1843, p. 26.

*Coluber corais* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 31.

### 14. DRYMARCHON CORAIS COLLARIS (Steindachner)

*Geoptyas collaris* Steindachner, Sitz. Ber. Akad. Wiss. Wien, vol. 55, 1867, p. 271, pl. 3, figs. 4–7.

*Coluber corais*, var. *collaris* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 32.

Ecuador.—1 specimen, No. 14025, collected by W. H. Jones.

### 15. DRYMARCHON CORAIS FLAVIVENTRIS (Steindachner)

*Geoptyas flaviventris* Steindachner, Sitz. Ber. Akad. Wiss. Wien, vol. 55, 1867, p. 269, pl. 4, figs. 4–7.

*Coluber corais*, var. *flaviventris* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 32.

Dutch Guiana.—1 specimen, in bad condition, No. 11147, collected by C. J. Hering.

### 16. CHIRONIUS CARINATUS (Linnaeus)

*Coluber carinatus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 223.

*Chironius carinatus* FITZINGER, Neue Classif. Rept., 1826, pp. 29, 31, and 60.

*Erpetodryas carinatus* BOIE, Isis, 1827, p. 548.

*Herpetodryas carinatus* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 73.

*Chironius carinatus* RUTHVEN, Misc. Publ., Univ. Michigan Mus. Zool., vol. 8, 1922, p. 65.

Dutch Guiana.—2 specimens, Nos. 11313 and 12547, collected by C. J. Hering.

Brazil.—2 specimens, No. 28947, collected by Mr. Steere, and No. 40217, collected in Santa Catharina, by Mr. Ehrhardt.

Paraguay.—1 specimen, No. 12402, collected by the Paraguay Expedition.

### 17. CHIRONIUS VICINUS (Boulenger)

*Herpetodryas vicinus* BOULENGER, Proc. Zool. Soc. London, 1915, p. 660. (Type from Anda Goya, So. Colombia).

Ecuador.—4 specimens, as follows:

| Number | Collector | Sc. | V. | A. | C. | Up. Lab. | Temp. | Length |
|---|---|---|---|---|---|---|---|---|
| 20,619 (juv.) | Mr. Kerr | 10 | 158 | 1/1 | 150 p. | 10(4,5,6) | 2+2 | 545 mm. (200 m. tail). |
| 20,620 | do | 10 | 157 | 1/1 | 158 p. | 9(4,5,6) | 2+2 | 2,170 mm. (805 mm. tail). |
| 20,621 | do | 10 | 160 | 1/1 | 148 p. | 9(4,5,6) | 2+2 | 1,520 mm. (610 mm. tail). |
| 32,044 (juv.) | Mr. Stuart | 10 | 159 | 1/1 | 133 p. | 9(4,5,6) | 2+2 | 540 mm. (145 mm. tail). |

The dorsal scales are all smooth in Nos. 20619 and 32044 (young specimens), the vertebral pair is faintly keeled in No. 20621 and in No. 20620 (old specimen) all scales are faintly keeled but the outer row which is smooth and the vertebral pair which is strongly keeled.

The ventrals are feebly angulate laterally in all specimens. Coloration as in the type, but in No. 20619 there are no spots or streaks along the vertebral line, and no dark streak under the tail. Nos. 20620 and 20621 show a tendency to be unicolor, reddish or dark brown, only slightly blotched on the sides, with traces of a dark streak behind the eye, dark yellow beneath anteriorly with irregular blackish blotches on the sides, posteriorly dark brown.

### 18. LEPTOPHIS AHAETULLA (Linnaeus)

*Coluber ahaetulla* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 225.

*Leptophis liocercus* JAN, Icon. Ophid., pt. 49, 1879, pl. 6, fig. 1.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 113.

*Leptophis ahaetulla* LOENNBERG, Bih. Svenska Vet. Akad. Handl., vol. 22, 1896, sec. 4, no. 1, p. 6.—ANDERSSON, Bih. Svenska Vet.-Akad. Handl., vol. 24, 1899, sec. 4, no. 6, p. 22.

Dutch Guiana.—2 specimens, No. 6116, collected by C. J. Hering.

### 19. LEPTOPHIS LIOCERCA (Berthold)

*Dendrophis liocercus* BERTHOLD, Abh. Ges. Wiss. Goettingen, vol. 3, 1847, p. 11.
*Ahaetulla occidentalis* GUENTHER, Proc. Zool. Soc. London, 1859, p. 412.
*Leptophis occidentalis* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 111.

Ecuador.—4 specimens, No. 12272, from Guayaquil; No. 12352, collected in Guayaquil by F. N. Clark, and Nos. 14021 and 14039 collected by Dr. W. H. Jones.

### 20. LEPTOPHIS RIVETI Despax

*Leptophis riveti* DESPAX, Bull. Mus. Hist. Nat. Paris, 1910, p. 26.

Ecuador.—1 specimen: No. 62791, male, sc. 15, v. 138, a. 1, c. 109 p., t. 1 2/1 1; dorsal scales strongly keeled but the outer row; keels present from neck to tip of tail; bluish brown above, keels of scales and sides of ventrals lighter; lips, chin, and throat yellowish.

### 21. LEIMADOPHIS[3] POECILOGYRA (Wied)

*Coluber poecilogyrus* WIED, Abbild. Naturg. Brasil., 1824, p. 8.
*Liophis poecilogyrus* JAN, Arch. Zool. Anat. Phys., vol. 2, 1863, p. 291.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 131.

Brazil.—1 specimen, No. 11135, collected in Rio de Janeiro by W. Harrison.

Uruguay.—3 specimens, Nos. 65550 and 65600, collected in Minas by Dr. F. Felippone and No. 64119, collected in San Vicente, Department Rocha, by A. Wetmore.

### 22. LEIMADOPHIS ALMADENSIS (Wagler)

*Natrix almadensis* WAGLER, in Spix, Species Novae Serp. Brazil., 1824, p. 30, pl. 10, fig. 3.
*Leimadophis almadensis* FITZINGER, Syst. Rept., 1843, p. 26.
*Liophis almadensis* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 78.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 134.

Paraguay.—2 specimens, No. 12402, collected by the Paraguay Expedition.

### 23. LEIMADOPHIS REGINAE (Linnaeus)

*Coluber reginae* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 219.
*Liophis reginae* GUENTHER, Cat. Snakes Brit. Mus., 1858, p. 46.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 137.

Brazil.—1 specimen, No. 28945, collected in the Lower Amazon by Mr. Steere.

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[3] The generic name *Leimadophis* Fitzinger, 1843 (Syst. Rept., 1843, p. 26) must be reserved for those species the type of which is *almadensis* (genus *Liophis* in Boulenger's Catalogue) while the name *Liophis* Fitzinger, 1843 (same reference) must be reserved for those species the type of which is *cobella* (genus *Rhadinaea* in Boulenger's Catalogue).

### 24. LEIMADOPHIS SAGITTIFERA (Jan)

*Liopeltis sagittifer* Jan, Elenco Sist., 1863, p. 82.
*Rhadinaea sagittifera* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 165.
*Liophis sagittifer* Peracca, Bol. Mus. Zool. Anat. Comp. Univ. Torino, 1896, no. 11, pp. 3–4.
*Rhadinaea modesta* Koslowski, Revista Mus. LaPlata, vol. 7, 1896, p. 453.
*Leimadophis sagittifer* Amaral, Revista Mus. Paulista, vol. 14, 1924, pp. 19–21.

A revision of this species is found in Amaral's paper.

Argentina.—6 specimens, No. 12408 (2 specimens) from Buenos Aires; No. 11387 collected in Mendoza by M. Sanchez; No. 52589 collected in Mendoza by C. S. Reed; No. 52967 collected in Mendoza by R. Sanzin; No. 64130 collected in Mendoza by Dr. A. Wetmore.

### 25. XENODON MERREMII (Wagler)

*Ophis merremii* Wagler, in Spix, Species Novae Serp. Brasil., 1824, p. 47, pl. 17.
*Xenodon merremii* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 150.

Brazil.—1 specimen, No. 28948, collected in the Lower Amazon by Mr. Steere.

### 26. XENODON NEUWIEDII Guenther

*Xenodon neuwiedii* Guenther, Ann. Mag. Nat. Hist., ser. 3, vol. 12, 1863, p. 354, pl. 5, fig. C.—Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 148.—Amaral, Revista Mus. Paulista, vol, 12, 1924, pp. 23–25.
*Xenodon hemileucurus* Lutz and Mello, Folha Medica, March 16, 1920.

Brazil.—1 specimen, No. 39073, collected in Alto da Serra, Sao Paulo and sent as *X. severus* by Dr. V. Brazil: sc. 21, v. 170, a. 1/1, c. 68 p.; ventrals very obtusely angulate laterally; maxillary teeth 14+2.

### 27. APOROPHIS LINEATA (Linnaeus)

*Coluber lineatus* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 221.
*Aporophis lineatus* Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 191.—Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 158.

British Guiana.—1 specimen, No. 12736, collected at Demerara River by Mrs. L. Curtis. Common name "Orococo."

### 28. APOROPHIS TAENIURA (Tschudi)

*Liophis taeniurus* Tschudi, Fauna Peruv., Herp., 1845, p. 51, pl. 5.
*Liophis reginae*, vars. *albiventris* and *quadrilineata* Jan, Arch. Zool. Anat. Physiol., vol. 2, 1863, p. 294.
*Aporophis taeniurus* Cope, Proc. Amer. Philos. Soc., vol. 18, 1879, p. 277.—Boulenger, Ann. Mag. Nat. Hist., ser. 8, vol. 1, 1908, p. 115.
*Liophis taeniurus*, *L. albiventris* Boulenger, Cat. Snakes Brit. Mus., vol. 2 p. 130.

Ecuador.—1 specimen, No. 62792, collected by F. W. Goding: sc. 19, without pits, vent. 155, caud. 63 pairs, postoc. 2. Only one lateral (black) streak from the middle of the body to the tip of the tail; belly unspotted.

Peru.—1 specimen, No. 60735; sc. 19, without pits, vent. 169, caud. 64 pairs, postoc. 2. Caudal streak present. San Miguel Bridge, ruins of Machu Pichu, Urubamba Valley, collected by E. Heller on July 2, 1916.

### 29. LIOPHIS SEMIAUREA (Cope)

*Opheomorphus merremii*, var. *semiaureus* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 348.

*Opheomorphus fuscus* COPE, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 190.

Uruguay.—2 specimens, Nos. 65602 and 65604, collected in Santa Lucia, Canelones, by Dr. F. Felippone.

### 30. LIOPHIS OBTUSA (Cope)

*Rhadinaea obtusa* COPE, Proc. Acad. Sci. Philadelphia, 1863, p. 101.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 171.

Uruguay.—2 specimens, Nos. 65554 and 65555, collected in Cerro, Montevideo, by Dr. F. Felippone.

### 31. LIOPHIS ANOMALA (Guenther)

*Coronella anomala* GUENTHER, Cat. Snakes Brit. Mus., 1858, p. 37.

*Rhadinaea anomala* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 165.—AMARAL, Revista Mus. Paulista, vol. 14, 1924, pp. 16–19.

*Rhadinaea elegantissima* KOSLOWSKY, Revista Mus. La Plata, vol. 7, 1895, p. 155.

A revision of this species is found in Amaral's paper.

Argentina.—2 specimens, No. 12367, from Buenos Aires.

### 32. LIOPHIS COBELLA (Linnaeus)

*Coluber cobella* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 218.

*Liophis cobella* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 698.

*Rhadinaea cobella* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 166.—LOENNBERG, Bih. Svenska Vet.Akad. Handl., vol. 22, 1896, sec. 4, No. 1, p. 6.—ANDERSSON, Bih. Svenska Vet.Akad. Handl., vol. 24, 1899, sec. 4, No. 6, p. 11.

Dutch Guiana.—2 specimens, Nos. 12551 and 13817, collected by C. J. Hering.

### 33. LIOPHIS FULVICEPS (Cope)

*Rhadinaea fulviceps* COPE, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 279.

Panama.—1 specimen, No. 50121, in bad condition.

### 34. LIOPHIS ALBICEPS (Amaral)

*Rhadinaea albiceps* AMARAL, Journ. Washington Acad. Sci., vol. 14, 1924, No. 9, p. 200.

Ecuador.—1 specimen, No. 22446 (type). This specimen is probably from Ecuador, whence it came with a collection sent by Mark B. Kerr, in May, 1895.

### 35. LYSTROPHIS SEMICINCTA (Duméril and Bibron)

*Heterodon semicinctus* Duméril and Bibron, Erp. Gén., vol. 7, 1854, p. 774

*Lystrophis semicinctus* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 153.

Argentina.—1 specimen, No. 52591, collected in Cerros de Mendoza by C. S. Reed.

### 36. UROTHECA ELAPOIDES ELAPOIDES (Cope)

*Pliocercus elapoides* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 253.

*Pliocercus euryzonus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 72.

*Urotheca elapoides*, *U. euryzonus* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 182.

Ecuador.—1 specimen, No. 32038, collected by F. L. Stuart.

### 37. DIMADES PLICATILIS (Linnaeus)

*Coluber plicatilis* Linnaeus, Syst. Nat., ed. 10, 1758, p. 217.

*Dimades plicatilis* Gray, Zool. Misc., 1842, p. 65.—Boulenger, Cat. Snakes, Brit. Mus., vol. 2, 1894, p. 186.

Paraguay.—1 specimen, No. 12,400, collected by the Paraguay Expedition.

### 38. HYDROPS TRIANGULARIS (Wagler)

*Elaps triangularis* Wagler, in Spix, Species Novae Serp. Brasil, 1824, p. 5, pl. 2*a*, fig. 1.

*Hydrops triangularis* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 187.

Dutch Guiana.—1 specimen, No. 11,150, collected by C. J. Hering.

Brazil.—1 specimen, No. 6,009, collected in the Amazon Valley by Lieutenant Herndon.

### 39. LAMPROPELTIS MICROPHOLIS Cope

*Lampropeltis micropholis* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 257.—Blanchard, U. S. Nat. Mus., Bull. 114, 1921, p. 149.

*Coronella micropholis* Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 203.

Ecuador.—6 specimens, Nos. 62,809–14, collected by F. W. Goding.

These specimens show all the variations in coloration referred to by Blanchard (p. 150).

### 40. ATRACTUS ROULEI Despax

*Atractus roulei* Despax, Bull. Mus. Hist. Nat. Paris, 1910, p. 30.

Ecuador.—2 specimens, Nos. 33,861–2, collected in the Alausi Valley by Mr. Davis:

| Number | S. | V. | A. | C. | Temp. | Praeoc. | Loreal | Postoc. | Total length |
|---|---|---|---|---|---|---|---|---|---|
| 33, 861 | 15 | 159 | 1 | 24 | 12 | None__ | 2½ as long__ | 1 | 140 mm. |
| 33, 862 | 15 | 157 | 1 | 22 | 12 | None___ | 2½ as long__ | 1 | 130 mm. |

### 41. PETALOGNATHUS NEBULATUS (Linnaeus)

*Coluber nebulatus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 222.
*Petalognathus nebulatus* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 464.—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 293.

Dutch Guiana.—1 specimen, No. 11,146, collected by C. J. Hering; v. 175, c. 90 pair, lab. 7 (4th and 5th), postoc. 2; chin-shields, 3 pairs.

Ecuador.—2 specimens, No. 14,035, collected by Dr. W. H. Jones: v. 191, c. 70 pair, lab. 7 (4th and 5th), postoc. 2; chin-shields 3 pairs; No. 14038, collected by Mr. Wachusett: v. 193, c. 79 pair, lab. 7 (4th and 5th), postoc. 2; chin-shields 3 pairs.

### 42. SIBYNOMORPHUS MACROSTOMUS Amaral

*Sibynomorphus macrostomus* AMARAL, Journ. Washington Acad. Sci., vol. 14, 1924, no. 9, p. 200.

Ecuador.—1 specimen, No. 14,047 (Type).

### 43. SIBYNOMORPHUS MIKANII (Schlegel)

*Dipsas mikanii* SCHLEGEL, Physiogn. Serp., vol. 2, 1837, p. 277.
*Leptognathus mikani* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 453.
*Leptognathus peruanus* BOETTGER, Kat. Rept. Mus. Senckenberg., 1898, pt. 2, p. 128.
*Sibynomorphus mikani* RUTHVEN, Miscell. Publ. Univ. Michigan Mus. Zool., vol. 8, 1922, p. 69.

Ecuador.—7 specimens, collected in Guayaquil by F. W. Goding.

Peru.—1 specimen, collected in Puquiura, by E. C. Erdis, in June, 1915, and referred to *S. peruanus* by Barbour and Noble.[4]

The examination of this series suggested a comparative revision of the species *S. mikanii* and *S. peruanus* (type from Santa Ana, Cuzco, Peru) which Boettger considered a valid form, differing especially in coloration, (belly, head and lips), number and disposition of upper labials, size of internasals, its formula being: sc. 15; v. 180; a. 1; c. 79 pairs plus 1; lab. 8 (3, 4, 5); temp. 2+3; 4 pairs of chin-shields, anterior much longer than broad. The examination of the specimen in the United States National Museum and another series in the Museum of Comparative Zoology yielded the following figures and data:

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[4] Proc. U. S. Nat. Mus., vol. 58, 1920, p. 620.

*Specimens of Sibynomorphus mikanii examined*

| Number | Locality | V. | C. | Lab. | Length in mm. Inter-nasals: praefrontal (ratio) | Temp. | Praeoc. | Postoc. | Chin-shields | Coloration (head and belly) |
|---|---|---|---|---|---|---|---|---|---|---|
| 60,718 U. S. N. M. | Puquiura, Peru | 178 | 78 p. | 9(4, 5, 6) | 1, 25:2 | 2+3 | 1 above loreal | 2/3 | 4 pairs, anterior longer than broad. | As in Boulenger's var. C. |
| 60,006 (juv.) U. S. N. M. | Guayaquil, Ecuador. | 179+½ | 53 p+ | 7(4, 5)/8(4, 5, 6) | 1:2 | 2+2/1+2 | None | 2 | 3 pairs anterior longer. | Do. |
| 60,797 U. S. N. M. | do | 181 | 76 p. | 8(4, 5, 6) | 1, 25:2 | 2+2/2+2 | 1 above loreal | 2/3 | 4 pairs anterior longer. | Do. |
| 60,798 U. S. N. M. | do | 182 | 75 p. | (Head injured) | | | | | 3 pairs anterior longer. | Do. |
| 60,799 (juv.) U. S. N. M. | do | 174 | 74 p. | 7(4, 5) | 1:2 | 2+3 | None | 3 | do | Do. |
| 60,800 (juv.) U. S. N. M. | do | 180 | 84 p. | 7(3, 4, 5)/7(4, 5) | 1, 25:2 | 2+3/2+4 | 1 above loreal | 3 | do | Do. |
| 60,801 (juv.) U. S. N. M. | do | 179 | 77 p. | 8(4, 5, 6)/8(3, 4, 5) | 1, 25:2 | 3+3/1+3 | None | 2 | do | Do. |
| 60,802 (juv.) U. S. N. M. | do | 184+½ | 86 p. | 8(4, 5, 6) | 1:2 | 2+3 | 1 above loreal | 2/3 | do | Do. |
| 17,083 (juv.) M. C. Z. | Chan-Chan Valley, Ecuador. | 171 | 88 p. | 8(4, 5, 6) | 1:2 | 3+3/2+3 | 1 above loreal | 4/3 | do | Do. |
| 17,099 (juv.) M. C. Z. | do | 179 | 85 p. | 7(4, 5) | 1, 25:2, 25 | 1+2 | None | 2 | do | Do. |
| 6,542 M. C. Z. | La Concepcion, Colombia. | 183 | 92 p. | 7(4, 5) | 1, 25:2, 25 | 1+2 | 1 | 2 | 3 pairs, anterior much longer than broad. | Do. |
| 17,825 M. C. Z. | S. Paulo, Brazil | 173 | 62 p+ | 7(3, 4) | 1:2 | 1+2 | None | 2 | 3 pairs, anterior longer. | As in Boulenger's var. B. but belly powdered with black. |
| 17,826 M. C. Z. | do | 177 | 66 p. | 7(3, 4) | 1:2 | 1+2 | None | 2 | do | As in Boulenger's var. B. |
| 17,827 M. C. Z. | do | 168 | 62 p. | 7(3, 4) | 1:2 | 2+2/1+2 | None | 2 | do | Do. |

The above table shows that the individuals of this species vary very much. Therefore, I am inclined to follow Boulenger and regard the differences shown by the specimens from the western side of South America only as color variations of *S. mikanii.*

### 44. DIPSAS INDICA Laurenti

*Dipsas indica* LAURENTI, Syn. Rept., 1768, p. 90.
*Dipsas bucephala* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 461.

Peru.—1 specimen: No. 60734, from the Comberciato River, collected by E. Heller.

### 45. IMANTODES CENCHOA (Linnaeus)

*Coluber cenchoa* LINNAEUS, Syst. Nat., ed. 10, vol.1, 1758, p. 226.
*Imantodes cenchoa* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 1065.
*Himantodes cenchoa* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 84.

Colombia.—2 specimens: No. 4300, sent from New Grenada by Mr. Schott: 1 praeocular; 2+3 postoculars; 3+3 temporals. No. 11270, sent from Madina River by Dr. Ruth.

Ecuador.—4 specimens: No. 14036, collected by Dr. W. H. Jones: 1 praeocular; 2 postoculars; 2+3 temporals. No. 20614: 1 praeocular; 2 postoculars; 2+3 temporals; and No. 20615: 1 praeocular; 3 postoculars; 3+3 temporals, both collected by Mark B. Kerr. No. 56320 from Napo: 1 praeocular; 2 postoculars; 2+3 temporals.

Trinidad.—4 specimens: No. 14496, collected by A. H. Riise: 1 praeocular; 1 postocular; 2+2/2+1 temporals. Nos. 14498 and 17499: 1 praeocular; 2 postoculars; 2+2 temporals; and No. 17450: 1 praeocular; 2 postoculars; 1+2 temporals; all collected by Mr. Wayman.

### 46. LEPTODEIRA ANNULATA (Linnaeus)

*Coluber annulatus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 224.
*Coluber albofuscus* LACÉPÈDE, Hist. Nat. Serp., vol. 2, 1789, p. 94.
*Leptodeira annulata* GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 166.
*Leptodeira albofusca* GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 166.
*Leptodira annulata* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 97.
*Leptodira albofusca* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 95.
*Leptodeira annulata* GRIFFIN, Ann. Carnegie Mus., vol. 11, 1917, p. 321.

Panama.—8 specimens: Nos. 54160, 54161, 54077, 54078, 53829, 54227, 45567, and 54266.

Colombia.—2 specimens: No. 11272 collected at Madina (?) River by Dr. Ruth. No. 32277, collected at Truando (?).

Ecuador.—1 specimen: No. 22444, collected by Mark B. Kerr.

Peru.—2 specimens: Nos. 28295 and 28296, sent from Ignitas by Mr. Carter.

Dutch Guiana.—8 specimens: Nos. 11149, 11154, 11156, 11158, 11160, 11161, 11162, and 12549; all collected by C. J. Hering.

### 47. PSEUDOBOA PETOLA (Linnaeus)

*Coluber petola* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 225.
*Coluber petolarius* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 225.
*Oxyrhopus petolarius* Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 101.
*Clelia peruviana* Griffin, Mem. Carnegie Mus., vol. 7, 1915, p. 204.
*Pseudoboa petola* Amaral, Rev. Mus. Paulista, vol. 14, 1924, p. 13.

Panama.—2 specimens: Nos. 50111 and 65867.

Ecuador.—3 specimens: No. 22445, collected by Mark B. Kerr. Nos. 32036 and 32037, collected by Mr. Stuart.

### 48. PSEUDOBOA TRIGEMINA (Duméril and Bibron)

*Oxyrhopus trigeminus* Duméril and Bibron, Erp. Gén., vol. 7, 1854, p. 1013.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 104.
*Pseudoboa trigemina* Amaral, Rev. Mus. Paulista, vol. 14, 1924, p. 12.

Paraguay.—2 specimens: No. 12381 (1 and 2), collected by the Paraguay Expedition.

### 49. PSEUDOBOA RHOMBIFERA (Duméril and Bibron)

*Oxyrhopus rhombifer* Duméril and Bibron, Erp. Gén., 1854, p. 1018.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 103.
*Pseudoboa rhombifera* Amaral, Rev. Mus. Paulista, vol. 14, 1924, p. 12.

Uruguay.—1 specimen: No. 65610 sent from Cerro Largo, by Dr. Florentino Felippone.

### 50. PSEUDOBOA MACULATA (Boulenger)

*Oxyrhopus maculatus* Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 110.

Argentina.—1 specimen, No. 11388: sc. 19–21–19–17; v. 245; a. 1; c. 52 pairs; anterior chin-shields a little longer than posterior; total length 1,850 mm.; tail 230 mm. Female sent from Mendoza by Dr. Day.

This specimen has a very high number of ventrals and is the largest ever recorded in collections.

### 51. PSEUDOBOA RUSTICA (Cope)

*Oxyrhopus rusticus* Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 92.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 111.
*Pseudoboa rustica* Amaral, Rev. Mus. Paulista, vol. 14, 1924, p. 12.

Argentina.—1 specimen, No. 64129, sent from Tafi Viejo, Tucuman, by Dr. Alexander Wetmore.

### 52. PSEUDOBOA FITZINGERI (Tschudi)

*Siphlophis fitzingeri* Tschudi, Fauna Peruv., Herpet., 1846, p. 56, pl. 8.
*Oxyrhopus fitzingeri* Jan, Elenco Sist., 1863, p. 93.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 108.

Peru.—2 specimens. No. 48552 sent from Piura by C. H. T. Townsend; male, sc. 19; v. 203, c. 73 pairs.

The lesser number of ventrals of this specimen, as compared with Boulenger's figures (232–236), may be related to the sex. No. 51512 sent from Canon Verruga, by C. H. T. Townsend; female, sc. 19; v. 227; c. 79 pairs.

### 53. PSEUDOBOA CLOELIA (Daudin)

*Coluber cloelia* DAUDIN, Hist. Nat. Rept., vol. 6, 1803, p. 330, pl. 78.
*Oxyrhopus cloelia* GUENTHER, Cat. Snakes Brit. Mus., 1858, p. 189.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 108.
*Pseudoboa cloelia* AMARAL, Rev. Mus. Paulista, vol. 14, 1924, pp. 11–12.

Ecuador.—1 specimen, No. 20622, collected by Mark B. Kerr, lab. 7 (3, 4); t. 2+3; sc. 19; c. 91 pairs plus 3.

Venezuela.—1 specimen, No. 32218, sent from Caracas by Capt. G. Wayright.

Brazil.—2 specimens No. 39061 sent as *Rhachidelus brazili* from Butantan, Sao Paulo, by Dr. V. Brazil: lab. 7 (3, 4), t. 2+2; sc. 19. No. 11,384 sent from Rio by J. R. Moran: lab. 7 (3, 4), t. 2+2; sc. 19. This specimen as well as No. 20622 shows that the disposition of the subcaudals is variable and consequently does not warrant the division of the genus *Pseudoboa* into *Pseudoboa* and *Cloelia* as accepted by most of the North American herpetologists.

### 54. PSEUDOBOA NEUWIEDII (Duméril and Bibron)

*Scytale neuwiedii* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 1001 (part).
*Pseudoboa neuwiedii* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 260.
*Oxyrhopus neuwiedii* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 112.
*Pseudoboa robinsoni* STEJNEGER, Proc. U. S. Nat. Mus., vol. 24, 1902, p. 190.

Venezuela.—1 specimen, No. 22532, sent from La Guaira by Capt. Wirt Robinson.

This is Stejneger's type of *Pseudoboa robinsoni* which, as I have published elsewhere[5] I consider only as an anomalous specimen of *Pseudoboa neuwiedii.*

### 55. PSEUDOBOA GUERINI (Duméril and Bibron)

*Rhinosimus guerini* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 991, pl. 72.
*Oxyrhopus guerini* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 113.
*Pseudoboa guerini* AMARAL, Rev. Mus. Paulista, vol. 14, 1924, p. 12.

Paraguay.—1 specimen, No. 12414, collected by the Paraguay Expedition.

### 56. BARBOURINA EQUATORIANA Amaral.

*Barbourina equatoriana* AMARAL, Journ. Washington Acad. Sci., vol. 14, 1924, no. 9, p. 201.

Ecuador.—1 specimen, No. 62790 (type), sent from Guayaquil by F. W. Goding in April, 1920.

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[5] Rev. Mus. Paulista, vol. 14, 1924, p. 26.

### 57. TACHYMENIS PERUVIANA Wiegmann

*Tachymenis peruviana* WIEGMANN, Nova Acta Acad. Leopold. Carol., vol. 17, 1835, pt. 1, p. 252, pl. 20, fig. 1.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 118.

Ecuador.—1 specimen, No. 12277, from Guayaquil.

### 58. THAMMODYNASTES PALLIDUS (Linnaeus)

*Coluber pallidus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 221.

*Coluber strigilis* THUNBERG, Mus. Acad. Upsal., 1788, pt. 1, p. 22.

*Coluber nattereri* MIKAN, Delic. Flor. Faun. Brasil., 1820, pl., fig. 1.

*Thammodynastes nattereri* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 116.

*Thammodynastes punctatissimus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 117.

*Thammodynastes strigilis* LOENNBERG, Bih. Svenska Vet. Akad. Handl., vol. 22, 1896, sec. 4, no. 1, p. 38.

*Thammodynastes pallidus* ANDERSSON, Bih. Svenska Vet. Akad. Handl., vol. 24, 1899, sec. 4, no. 6, p. 17.—AMARAL, Rev. Mus. Paulista, vol. 14, 1924, pp. 27—29.

A revision of this species is found in Amaral's paper.

Colombia.—1 specimen, No. 14717, sent by V. O. King.

Paraguay.—1 specimen, No. 11260, sent by Dr. Palmer.

### 59. PHILODRYAS VIRIDISSIMSUS (Linnaeus)

*Coluber viridissimus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 226.

*Philodryas viridissimus* GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 123.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 129.

Dutch Guiana.—1 specimen, No. 11157, collected by C. J. Hering.

### 60. PHILODRYAS OLFERSII (Lichtenstein)

*Coluber olfersii* LICHTENSTEIN, Verz. Doubl. Berlin Mus., 1823, p. 104.

*Philodryas olfersii* GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 123.

*Philodryas olfersii*, var. *reinhardtii* (Guenther) BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 129.

Paraguay.—1 specimen, No. 12327, collected by the Paraguay Expedition.

### 61. PHILODRYAS SCHOTTII (Schlegel)

*Xenodon schottii* SCHLEGEL, Physiogn. Serp., vol. 2, 1837, p. 91, pl. 3, figs. 8 and 9.

*Philodryas schottii* GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 125.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 130.

Paraguay.—1 specimen, No. 11261 collected by Dr. Palmer.

Argentina.—3 specimens; No. 16423, collected in Rosario by the La Plata Expedition. No. 52588, collected at Rio Negro by Dr. Carlos S. Reed, length 1,580 mm., tip of tail missing. No. 63947 collected by Dr. Alexander Wetmore.

### 62. PHILODRYAS ELEGANS (Tschudi)

*Lygophis elegans* TSCHUDI, Faun. Peruv., Herp., 1845, p. 53, pl. 6.
*Philodryas elegans* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 133.

Chile.—1 specimen, No. 64121 collected in Valparaizo, by Dr. Carlos S. Reed.

### 63. PHILODRYAS PSAMMOPHIDEUS Guenther

*Philodryas psammophideus* GUENTHER, Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 23, pl. 4, fig. A.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 132.
*Philodryas bolivianus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 132.
*Philodryas borellii* PERACCA, Boll. Mus. Zool. Anat, Univ. Torino, vol. 12, 1897, no. 274, p. 14.
*Philodryas psammophideus* AMARAL, Rev. Mus. Paulista, vol. 14, 1924, p. 31.

A revision of this species is found in Amaral's paper.

Argentina.—3 specimens: Nos. 52593 (sc. 19; v. 196; c. 87 p.); 52594 (sc. 19; v. 196; c. 86 p.); 52595 (juv. sc. 19; v. 190; c. 90 p.) all collected in Mendoza by Dr. Carlos S. Reed.

### 64. PHILODRYAS BURMEISTERI (Jan)

*Dryophylax burmeisteri* JAN, in Burmeister, Reise La Plata, vol. 2, 1861, p. 529.
*Philodryas burmeisteri* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 135.

Argentina.—3 specimens: No. 7304 (c. 123) sent from Uspallata, by Mr. M'Lae, No. 52961 sent from Mendoza, by Renato Sanzin. No. 63945 (loreal fused with the praefrontal on both sides), collected at General Roca, Rio Negro, by Dr. Alexander Wetmore.

### 65. OXYBELIS ACUMINATUS (Wied)

*Coluber acuminatus* WIED, Isis, 1824, pt. 6, June, p. 667.
*Oxybelis acuminatus* STEINDACHNER, Novara Exped., Rept., 1867, p. 72.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 192.

Numerous specimens from various localities in Central and South America.

### 66. OXYBELIS ARGENTEUS (Daudin)

*Coluber argenteus* DAUDIN, Hist. Nat. Rept., vol. 6, 1803, p. 336.
*Oxybelis argenteus* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 815.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 190.

Dutch Guiana.—1 specimen, No. 11153 sent by C. J. Hering.

### 67. OXYBELIS BREVIROSTRIS (Cope)

*Dryophis brevirostris* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 555
*Oxybelis brevirostris* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 190.

Ecuador.—3 specimens: Nos. 20616, 20617, and 20618.

### 68. ERYTHROLAMPRUS AESCULAPII (Linnaeus)

*Coluber aesculapii* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 220.
*Erythrolamprus aesculapii* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 845.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 200.

Panama.—1 specimen, No. 65881.

Colombia.—1 specimen, No. 11273 collected at Madina (?) River, by Dr. Ruth.

### 69. ERYTHROLAMPRUS LABIALIS Werner

*Erythrolamprus labialis* WERNER, Mitt. Naturh. Mus. Hamburg, vol. 26, 1909, p. 237.

Eucador.—2 specimens: No. 62793: sc. 17, v. 169; a. 1/1; c. 79 p.; t. 1+2; total length 185 mm.; 4 lower labials in contact with the anterior chin-shields which are a little shorter than the posterior; 2d light lateral strip on the 5th scale row, instead of on the 4th as in the type. No. 62794: sc. 17; v. 159; a. 1/1; c. 97 p.; t. 1+1; lower labials and chin-shields as in the preceding; 2d light lateral strip on the suture of the 4th and 5th scale rows.

### 70. TANTILLA MELANOCEPHALA (Linnaeus)

*Coluber melanocephalus* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 218.
*Tantilla melanocephala* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 74.
*Homalocranium melanocephalum* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 215.

Uruguay.—2 specimens: No. 65537, collected in Cerro Largo by Dr. Florentino Felippone. No. 65549, collected in Paysandu, by the same.

### 71. STENORHINA DEGENHARDTII (Berthold)

*Calamaria degenhardtii* BERTHOLD, Abh. Ges. Wiss. Goettingen, vol. 3, 1846, p. 8, pl. 1, figs. 3-4.
*Stenorhina degenhardtii* JAN, Arch. Zool. Anat. Physiol., vol. 2, 1862, p. 63.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 229.

Panama.—1 specimen, No. 66586.

### 72. APOSTOLEPIS CEARENSIS Gomes

*Apostolepis cearensis* GOMES, Ann. Paulistas Med. Cirurg., vol. 4, 1915, p. 6, p. 122 (type from Ceará, Brazil).

Brazil.—1 specimen, No. 56401 collected in Ceará (J. Hurter collection), in August, 1893, and identified with *A. dorbignyi:* v. 232; c. 27 pairs; portion of the rostral visible from above ⅔ of the prefrontal suture; total length 285 mm.

### 73. ELAPOMORPHUS LEMNISCATUS Duméril and Bibron

*Elapomorphus lemniscatus* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 840.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 242.

Uruguay.—2 specimens, Nos. 65552 and 65599, both collected in Minas, by Dr. Florentino Felippone.

The internasals are broadly contiguous in No. 65552 and touch each other only by their inner angle in No. 65599. The degree of contiguity of the internasals is very variable among all the specimens of *Elapomorphus* having a single prefrontal, according to my experience. Boulenger's key for the differentiation of these species, which is based on this character, is therefore quite unreliable.

### 74. ELAPOMORPHUS SUSPECTUS Amaral

*Elapomorphus suspectus* AMARAL, Journ. Washington Acad. Sci., vol. 14, no. 9, 1924, p. 202.

Argentina.—1 specimen, No. 48939 (type) sent from Pilar, near Cordoba, by Dr. C. C. Craft.

### 75. PELAMYDRUS PLATURUS (Linnaeus)

*Anguis platura* LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 391.
*Hydrus platurus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 267.
*Pelamydrus platurus* STEJNEGER, Proc. U. S. Nat. Mus., vol. 38, 1910, p. 111.

Ecuador.—3 specimens, all from the coast of Guayaquil: No. 12347 (1st): 1 praeocular; 2 postoculars; 2 suboculars; 9/8 upper labials; (2nd): 1 praeocular; 2 postoculars; no subocular; 8 (4, 5) upper labials. No. 59433: 1 praeocular; 2 postoculars; 1 subocular; 10/9 upper labials.

### 76. MICRURUS SURINAMENSIS (Cuvier)

*Elaps surinamensis* CUVIER, Règne Anim., vol. 2, 1817, p. 84.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 414.

For the use of *Micrurus* instead of *Elaps* as a generic name for these Neotropical and Nearctic species see Stejneger and Barbour.[6]

Dutch Guiana.—1 specimen, female No. 66144 sent from Moengo by Mr. C. Bonne and identified with *M. fulvius:* lab. 7 (4th) v. 181; c. 29 p.; 7 sets of 3 black annuli on the body, 1 on the occiput, 1 on the anal region, and 1 on the tail; total length 1,220 mm.

### 77. MICRURUS HEMPRICHII (Jan)

*Elaps hemprichii* JAN, Rev. Mag. Zool., 1858, p. 523.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 421.

Dutch Guiana.—1 specimen, female, No. 64633, sent from Moengo, by Mr. C. Bonne: eye ⅔ its diameter from mouth; v. 181; c. 27 p.; black above with pinkish annuli, the black distributed in 8 triads of subequal annuli on the body and 1 on the tail; total length 805 mm.

### 78. MICRURUS TSCHUDII (Jan)

*Elaps tschudii* JAN, Rev. Mag. Zool., 1858, p. 524.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 422.

Peru.—1 specimen, female, No. 38588, sent by R. E. Coker; v. 207; c. 23 pairs + 5 single; total length 310 mm.; snout obtusely pointed;

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[6] Check-List N. A. Amph. Reptiles, 1917, p. 106, and Amaral Rev. Mus. Paulista, vol. 14, 1924, p. 3.

black annuli disposed more or less regularly in 11 sets of threes, the middle annulus ⅓ as wide as the outer ones; ground color of back yellowish-white; 1st set of rings on the occiput; head as in Jan's figure,[7] but the black part shows yellow sutures.

### 79. MICRURUS HETEROZONUS (Peters)

*Elaps heterozonus* Peters, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1881, p. 52.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 417.

Peru.—1 specimen, female, No. 60701, collected at the Cosireni River, 4,000 feet altitude, on September 10, 1915, as referred to by Barbour and Noble.[8] Female, v. 213; c. 17 pairs + 4 single; 16 black rings along the body more or less disposed in threes which character has not been emphasized by previous authors; the rings are narrower than their interspaces, which are a little lighter between two neighboring triads than those between internal rings of one triad; 2 rings on the tail; head coloration as described by Boulenger; total length 580 mm.

### 80. MICRURUS DISSOLEUCUS (Cope)

*Elaps dissoleucus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1859, p. 345.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 422.

Venezuela.—1 specimen of this rare and poorly described species. No. 59865, female, collected by Mr. Curran. Snout obtusely pointed; eye much shorter than its distance from the mouth; rostral broader than deep; frontal narrow and elongate, about twice as long as broad, shorter than the parietals which are very elongate and longer than their distance from the internasals; one prae and two postoculars; seven upper labials, third a little larger than fourth, and both entering the orbit, seventh well developed; temporals 1+1; three lower labials in contact with anterior chin-shields which are a little shorter than posterior; v. 199; a. 1/1; c. 22 p. Coloration: Six sets of 3 black rings, the middle one-third as wide as the outer; head black above with a yellow transverse band posteriorly situated and covering the posterior half of the frontal, supraocular, and 5th labial, all the upper postocular, 6th labial and anterior temporal, the anterior half of the 7th labial and all the posterior temporals and parietals. Total length, 450 mm.

### 81. MICRURUS MIPARTITUS (Duméril and Bibron)

*Elaps mipartitus* Duméril and Bibron, Erp. Gén., vol. 7, 1854, p. 1220.—Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 431.

*Elaps microps* Boulenger, Proc. Zool. Soc. London, 1913, p. 1036, pl. 108, fig. 2.

Ecuador.—2 specimens: No. 62795, female, sent by Mr. Goding: Eye small; t. 1+1, anterior very narrow; 4 lower labials in contact with the anterior chin-shields which are a little shorter than the posterior; 3d upper labial very large but 4th the largest; v. 267; c. 29 p.; black with 61 yellowish-white cross-bars widening on the belly which is barred with black and yellowish-white; white dorsal scales usually with a black spot; tail yellowish with 3 black rings; head as Boulenger's description for both *mipartitus* and *microps;* total length, 740 mm.

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[7] Icon. Gén., pt. 42, 1872, pl. 6, fig. 1.

[8] Proc. U. S. Nat. Mus., vol. 58, 1920, p. 619.

No. 62796, female, also sent by Mr. Goding: The same head shield disposition; v. 274; c. 29 pairs + 1 single; coloration the same, 62 cross bars on the body and 4 on the tail; total length, 545 mm.

### 82. MICRURUS FILIFORMIS (Guenther)

*Elaps filiformis* GUENTHER, Proc. Zool. Soc. London, 1859, p. 86, pl. 18 fig. B.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 430.

Colombia.—1 specimen, No. 4338, from Truando, New Granada, in bad condition.

### 83. MICRURUS ANCORALIS (Jan)

*Elaps marcgravi*, var. *ancoralis* JAN, Icon. Ophid., pt. 42, 1872, pl. 4, fig. 2. *Elaps ancoralis* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 432.

Ecuador.—1 specimen, No. 12267, female, collected in Guayaquil: v. 253, c. 32 p.; body with 15 triads of black rings, one on the tail and one near the nape; a very defined anchor-shaped marking on the occiput and nape; symphysial separated from anterior pair of chin-shields by 1st pair of lower labials, which is exceptional in this species; total length, 488 mm.

### 84. MICRURUS NARDUCCII (Jan)

*Elaps narducci* JAN, Arch. Zool. Anat. Physiol., vol. 2, 1863, p. 222 (type from Bolivia).—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 433.

Ecuador.—2 specimens, sent from Macas, Provincia d'El Oriente, by M. Madira: No. 65473, female; v. 320; c. 20 p.; black above with 52 transversely oval spots all yellow, some extending as irregular blotches down to the sides; 2 yellow rings on the tail as in Jan's figure;[9] total length 585 mm. No. 65474, male; v. 275; c. 23 p.; coloration as in No. 65473, with 43 oval yellow spots; yellow beneath, 1½ yellow rings on the tail; total length 497 mm.

### 85. MICRURUS FRONTALIS (Duméril and Bibron)

*Elaps frontalis* DUMÉRIL and BIBRON, Erp. Gén., vol. 7, 1854, p. 1223 (part).—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 427.

Argentina.—1 specimen, No. 52592, collected in Mendoza by Dr. Carlos S. Reed: 7 sets of 3 rings, the middle about 2 to 3 times as wide as the center.

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[9] Icon. Gén., 1872, p. 42, pl. 6, fig. 5.

### 36. MICRURUS CORALLINUS (Wied)

*Elaps corallinus* Wied, Nova Acta Acad. Leopold. Çarol., vol. 10, pt. 1, 1820, p. 108; Abbild. Naturg. Brasil., pt. 6, 1824, pl. 4.

*Elaps dumerilii* Jan, Rev. Mag. Zool., 1858, p. 522; Icon. Ophid., pt. 42, 1872, pl. 1, fig. 3.

*Elaps risei* Jan, Rev. Mag. Zool., 1858, p. 525, pl. B.; Icon. Ophid., pt. 42, 1872, pl. 6, fig. 3.

*Elaps corallinus* Boulenger, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 420.

The United States National Museum has 29 specimens of this very widespread species. Having carefully examined this material I was led into comparing it with those specimens in the Museum of Zoology of the University of Michigan and in the Carnegie Museum at Pittsburgh as well as those in the Museum of Comparative Zoology, supplemented with a few specimens recently received from both the Instituto do Butantan and the Museu Paulista. The total number of specimens examined was 101, distributed as follows:

| | |
|---|---|
| United States National Museum | 29 |
| University of Michigan Museum of Zoology | 2 |
| Carnegie Museum (Griffin's material) | 8 |
| Museum of Comparative Zoology (Inst. Butantan and Mus. Paulista) | 62 |
| Total | 101 |

The countries to which those speciments belong were the following:

| | |
|---|---|
| Trinidad | 21 |
| Venezuela | 1 |
| Colombia | 13 |
| Ecuador | 7 |
| Peru | 6 |
| Brazil | 51 |
| South America | 1 |
| Unknown | 1 |
| Total | 101 |

The most important characteristics of those specimens may be tabulated as follows:

*Specimens of Micrurus corallinus examined*

| Locality | No. | Museum | Sex | Temp. | V. | C. | Black annuli | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Body | Tail | Outer annuli |
| Trinidad | 5586 | U. S. N. M. | ♀ | 1+1 | 193 | 31 p. | 26 | 6 | None. |
| Do | 5586-1 | do | ♀ | 1+1 | 202 | 33 p. | 28 | 6 | Slight. |
| Do | 5586-2 | do | ♂ | 1+1 | 180 | 44 p. | 27 | 9 | None. |
| Do | 5586-3 | do | ♀ | 1+1 | 194 | 30 p.+2. | 29 | 6 | Slight. |
| Do | 5586-4 | do | ♀ | 1+1 | 198 | 30 p.+2. | 31 | 8 | None. |
| Do | 5586-5 | do | ♀ | 1+1 | 197 | 31 p. | 27+$\frac{2}{2}$ | 6 | Slight. |
| Do | 5586-6 | do | ♂ | 1/1+1 | 181+½ | 38 p.+5. | 25+½ | 10 | Marked. |
| Do | 5586-7 | do | ♂ | 1+1 | 183 | 41 p.+2. | 25 | 9 | Slight. |
| Do | 5586-8 | do | ♀ | 1+1/1 | 198 | 29 p.+2. | 29+½ | 7 | None. |
| Do | 5586-9 | do | ♂ | 1+1 | 187 | 44 p. | 25 | 12 | Marked. |
| Do | 5586-10 | do | ♀ | 1+1 | 195 | 29 p.+3. | 22 | 6 | None. |
| Do | 5586-11 | do | ♂ | 1+1 | 186 | 44 p.+2. | 26 | All black. | Do. |
| Do | 7481-1 | do | ♀ | 1+1 | 199 | 34 p. | 27+$\frac{2}{2}$ | 7 | Do. |
| Do | 7481-2 | do | ♂ | 1+1 | 185 | 43 p.+1. | 25 | 11 | Slight. |
| Do | 17736 | do | ♀ | 1/1 | 198 | 31 p. | 29 | 8 | None. |
| Do | 17737 | do | ♂ | 1/1+1 | 181 | 37 p.+10 | 30 | 11 | Slight. |
| Do | 17738 | do | ♂ | 1+1 | 185 | 46 p. | 29 | All black. | Do. |
| Do | 17739 | do | ♂ | 1+1 | 186 | 47 p. | 26 | 10 | None. |
| Do | 6123-1 | M. C. Z. | ♂ | 1/1 | 185 | 27 p.+14 | 29 | 9 | Marked. |
| Do | 6123-2 | do | ♂ | 1+1 | 182 | 45 p.+2. | 26 | 10 | Slight. |
| Do | 6123-3 | do | ♂ | 1/1 | 182 | 46 p. | 25 | 10 | Do. |
| Venezuela | 9996 | do | ♂ | 1+1 | 178 | 44 p. | 25 | 9 | None. |
| Colombia | 54339 | U. S. N. M. | ♂ | 1+1 | 190 | 53 p. | 16 | 7 | Marked. |
| Do | 45548 | Univ. Mich. | ♂ | 1+1 | 199 | 49 p. | 10 | 5 | Do. |
| Do | 47796 | do | ♂ | 1+1 | 180 | 49 p. | 12 | 11 | Do. |
| Do | 197 | Carn. Mus. | ♀ | 1+1 | 207 | 33 p. | 13 | 5 | Do. |
| Do | [1] 198 | do | ♀ | 1+1 | 206 | 35 p.+1. | 12 | 4 | Do. |
| Do | 2031 | do | ♂ | 1+1 | 185 | 43 p. | 12 | 6 | Slight. |
| Do | 199 | do | ♂ | 1+1 | 191 | 47 p. | 14 | 7 | Faded. |
| Do | 2033 | do | ♀ | 1+1 | 205 | 33 p. | 14 | 5 | Marked. |
| Do | 6535 | M. C. Z. | ♂ | 1+1 | 186 | 46 p. | 10 | 6 | Do. |
| Do | 6536 | do | ♂ | 1+1 | 183+½ | 44 p. | 11 | 6 | Do. |
| Do | 6537 | do | ♂ | 1+1/1+2 | 179 | 45 p.+1. | 12 | 6 | Slight. |
| Do | 6582 | do | ♀ | 1+1 | 198 | 32 p. | 15 | 4 | Marked. |
| Do | 13302 | do | ♀ | 1+1 | 209 | 38 p. | 16 | 6 | Slight. |
| Ecuador | 20624 | U. S. N. M. | ♀ | 1+1 | 211 | 38 p. | 19 | 6 | None. |
| Do | 22443 | do | ♂ | 1+1 | 198 | 56 p. | 17 | 7 | Do. |
| Do | 59432 | do | ♀ | 1+1 | 206 | 43 p. | 16 | 5 | Marked. |
| Do | 62808 | do | ♂ | 1+1 | 198 | 56 p. | 19 | 8 | None. |
| Do | 8399 | M. C. Z. | ♂ | 1+1 | 209 | 45 p. | 15 | 6 | Marked. |
| Do | 3559 | do | ♀ | 1+1 | 201 | 48 p. | 18 | 6 | Do. |
| Do | 3569 | do | ♀ | 1+1 | 213 | 34 p. | 19 | 4 | Do. |
| Peru | 17384 | do | ♀ | 1/1 | 198 | 27 p. | 18 | 4 | None. |
| Do | 17385 | do | ♂ | 1+1 | 190 | 33 p.+8. | 26 | 7 | Do. |
| Do | 17386 | do | ♂ | 1+2 | 207 | 45 p. | 25 | 9 | Do. |
| Do | 17387 | do | ♀ | 1/1 | 199 | 28 p. | 27 | 5 | Do. |
| Do | 17388 | do | ♀ | 1+1 | 200 | 30 p. | 26 | 5 | Do. |
| Do | 17389 | do | ♀ | 1+1 | 202 | 27 p. | 27 | 4 | Do. |
| Brazil | 2915-1 | do | ♀ | 1+1 | 217 | 27 p. | 20 | 4 | Do. |
| Do | 2915-2 | do | ♀ | 1+1 | 219 | 25 p.+5. | 21 | 4 | Do. |
| Do | 17855 | do | ♀ | 1+1 | 216 | 31 p. | 24 | 5 | Do. |
| Brazil (Esp. Santo). | 17856 | do | ♀ | 1+1 | 216 | 30 p. | 18+½ | 4 | Do. |
| Brazil (Rio). | 53362 | U. S. N. M. | ♀ | 1+1 | 211 | 27 p. | 20 | 4 | Do. |
| Do | 53363 | do | ♂ | 1+1 | 193 | 42 p. | 17+$\frac{2}{2}$ | 6 | Do |
| Do | 53364 | do | ♂ | 1+1 | 195 | 42 p. | 17+½ | 7 | Do. |
| Do | 2923-1 | M. C. Z. | ♀ | 1+1 | 216 | 26 p. | 22 | 4 | Do. |
| Do | 2923-2 | do | ♂ | 1+1 | 198 | 42 p. | 17 | 7 | Do. |
| Do | 3003 | do | ♀ | 1+1 | 217 | 30 p. | 22 | 5 | Do. |
| Do | 3205-1 | do | ♀ | 1+1 | 207 | 29 p. | 20 | 4 | Do. |
| Do | 3205-2 | do | ♂ | 1+1 | 196 | 43 p. | 19 | 8 | Do. |
| Do | [2] 1194 | do | ♀ | 1+1 | ? | ? | 20 | 4 | Do. |
| Do | 1374-1 | do | ♀ | 1+1 | 214 | 29 p. | 18 | 4 | Do. |
| Do | 1374-2 | do | ♂ | 1+1 | 196 | 44 p.+2. | 17 | 7 | Do. |
| Do | 1374-3 | do | ♂ | 1+1 | 199 | 43 p.+2. | 17 | 7 | Do. |
| Do | 1374-4 | do | ♀ | 1+1 | 210+$\frac{4}{2}$ | 28 p. | 21+½ | 4 | Do. |
| Do | 1374-5 | do | ♂ | 1+1 | 196 | 45 p.+2. | 15+$\frac{3}{2}$ | 7 | Do. |
| Do | 1374-6 | do | ♀ | 1+1 | 212 | 29 p. | 20+½ | 4 | Do. |
| Do | 1374-7 | do | ♀ | 1+1 | 211 | 27 p. | 22 | 4 | Do. |
| Do | 2648-1 | do | ♀ | 1+1 | 209 | 27 p. | 18 | 4 | Do. |
| Do | 2648-2 | do | ♂ | 1+1/1+2 | 196 | 40p.+2+$\frac{4}{2}$ | 17 | 6 | Do. |
| Do | 2648-3 | do | ♀ | 1+1 | 209+½ | 28 p. | 19+½ | 5 | Do. |
| Do | 2648-4 | do | ♀ | 1+1 | 206 | 28 p. | 19 | 4 | Do. |
| Do | 2648-5 | do | ♀ | 1+1 | 209 | 30 p. | 21 | 4 | Do. |
| Do | 2648-6 | do | ♀ | 1+1 | 207 | 23 p.+1. | 18+½ | 4 | Do. |
| Do | 2648-7 | do | ♀ | 1+1 | 209 | 27 p. | 21 | 4 | Do. |

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[1] This specimen is now No. 11865 M. C. Z.

[2] Under surface in bad condition.

*Specimens of Micrurus corallinus examined*—Continued

| Locality | No. | Museum | Sex | Temp. | V. | C. | Black annuli |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  | Body | Tail | Outer annuli |
| Brazil (Rio) | 2648-8 | M. C. Z. | ♂ | 1+1 | 196 | 40 p.+2 | 16+½ | 6 | None. |
| Do | 2648-9 | do | ♂ | 1+1 | 199 | 44 p. | 18 | 7 | Do. |
| Do | 2648-10 | do | ♀ | 1+1 | 206 | 29 p. | 22 | 4 | Do. |
| Do | 3498 | do | ♂ | 1+1/1+2 | 195 | 42 p.+4 | 16 | 8 | Do. |
| Do | 2653 | do | ♂ | 1+2/1+2 | 195 | 30 p.+4+ | 16+½ | 5+ | Do. |
| Do | 2678 | do | ♀ | 1+1 | 211 | 30 p. | 19 | 5 | Do. |
| Brazil (Minas). | 5568 | do | ♂ | 1+1 | $183+\frac{6}{2}$ | 31 p.+9 | 14 | 5 | Do. |
| Brazil (Goyaz). | 3489 | do | ♀ | 1+1 | 212 | 28 p. | 20 | 5 | Do. |
| Brazil (S. Paulo). | 12695 | do | ♂ | 1+1 | 207 | 44 p.+1 | 19 | 7 | Do. |
| Do | 12696 | do | ♀ | 1+1 | 213 | 28 p. | 16+½ | 4 | Do. |
| Do | 16675 | do | ♂ | 1+1 | 207 | 46 p. | 18+½ | 7 | Do. |
| Do | 17857 | do | ♀ | 1+1 | 215 | 27 p. | 20+½ | 4 | Do. |
| Do | 17859 | do | ♀ | 1+2/1+1 | 213 | 30 p. | 18 | 5 | Do. |
| Do | [3] 17858 | do | ♂ | 1+2 | 198 | 44 p. | 18 | 7 | Do. |
| Do | [4] 17860 | do | ♂ | 1+2/1+1 | 203 | 43 p. | 20 | 7 | Do. |
| Brazil (Paraná). | 17861 | do | ♀ | 1+1 | 213 | 28 p. | 17+½ | 4 | Do. |
| Brazil (Sta. Cath.). | 17755 | do | ♀ | 1+2/1+1 | 213 | 28 p. | 20 | 4 | Do. |
| Do | 17756 | do | ♀ | 1+1 | 213 | 29 p. | 20 | 4 | Do. |
| Do | 17757 | do | ♂ | 1+1/1+2 | 200 | 45 p. | 18 | 8 | Do. |
| Do | 17758 | do | ♀ | 1+1 | 217 | 30 p. | 19 | 4 | Do. |
| Do | 40218 | U. S. N. M. | ♀ | 1+1 | 221 | 30 p. | 20 | 4 | Do. |
| Do | 40219 | do | ♀ | 1+1 | 217 | 30 p. | 20 | 6 | Do. |
| Do | 40220 | do | ♀ | 1+1 | 217 | 30 p. | 21 | 4 | Do. |
| Brazil (M. Grosso). | 341 | Carn. M | ♀ | 1+1 | 213 | 29 p. | 24 | 6 | Do. |
| So. America | 261 | do | ♀ | 1+1 | 200 | 43 p. | 16 | 6 | Do. |
| Unknown | 1236 | do | ♂ | 1+1 | 195 | 44 p. | 15 | 6 | Do. |

[3] From the S. Sebastião Island. [4] From the Victoria Island.

Now, in summarizing the above figures according to both the sex and the geographical distribution of the various specimens, excluding the two that have no definite data, the averages are found to be as follows:

| Locality | Number of specimens | Sex | Ventrals | Caudals | Black annuli |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Body | Tail | Outer annuli |
| 1. Trinidad | 12 | ♂ ♂ | 180-187 | 41-47 | 25 -30 | 9-12 | Sometimes present. |
|  | 9 | ♀ ♀ | 193-202 | 31-34 | 22 -31 | 6- 8 |  |
| 2. Venezuela | 1 | ♂ | 178 | 44 | 25 | 9 | None. |
| 3. Colombia | 8 | ♂ ♂ | 179-199 | 43-53 | 10 -16 | 5-11 | Always present. |
|  | 5 | ♀ ♀ | 198-209 | 32-38 | 12 -16 | 4- 6 |  |
| 4. Ecuador | 3 | ♂ ♂ | 198-209 | 45-56 | 15 -19 | 6- 8 | Frequently present. |
|  | 4 | ♀ ♀ | 201-213 | 34-48 | 16 -19 | 4- 6 |  |
| 5. Peru | 2 | ♂ ♂ | 190-207 | 41-45 | 25 -26 | 7- 9 | Never present. |
|  | 4 | ♀ ♀ | 198-202 | 27-30 | 18 -27 | 4- 5 |  |
| 6. Brazil | 18 | ♂ ♂ | 186-207 | 40-47 | 14 -20 | 5- 8 | Never present. |
|  | 33 | ♀ ♀ | 206-221 | 24-31 | 17½-24 | 4- 6 |  |

Having thus examined a rather large series of Colombian and Ecuadorian specimens that, as a rule, showed outer rings on their body and so looked very much like *M. dumerilii* (Jan) as represented in Jan's figure[10] and as described in Boulenger's Catalogue,[11] I was led to compare *M. dumerilii* with *M. corallinus* in order to ascertain whether the former were to be considered a valid species or not.

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[10] Icon. Ophid., 1872, pt. 42, pl. 1, fig. 3.

[11] Cat. Snakes Brit. Mus., pt. 3, 1896, p. 419.

As represented in Boulenger's catalogue these two species can be distinguished from each other only by the following characteristics:

| | Frontal | Caudals | Outer black annuli |
|---|---|---|---|
| *M. dumerilii* | as long as the parietals | 50–53 | Present as to form triads, the median ones being much broader. |
| *M. corallinus* | a little shorter than the parietals | 30–47 | Not present. |

As far as the proportional length of the frontal is concerned, I have found it to be a very poor character. The ratio of frontal to parietal is 3:4.5 to 3:4.75 for specimens from Colombia and Ecuador, consequently from the same zoogeographical region as the type of *M. dumerilii* (Cartagena, Colombia), while for specimens from other regions the ratio is 3.25:3.75 to 4.5:6.5.

As regards the number of subcaudals the series examined shows them to vary from 32 to 56 in specimens from Colombia and Ecuador, thus agreeing with the figures assigned by Boulenger to specimens of his *M. corallinus* collected elsewhere.

Finally, the presence of outer rings in specimens from Colombia and Ecuador can not be taken as a specific difference firstly because Boulenger, himself, included in the synonymy of his *M. corallinus* Jan's *M. bocourti* that has marked outer rings as seen in Jan's figure,[12] secondly, because such rings are sometimes found in specimens from Trinidad.

On the strength of these data, I have decided to consider the specimens from Colombia and Ecuador as belonging to a local race. Likewise those from Trinidad and probably those from Venezuela must be given subspecific rank, as they can be distinguished from the typical form by the number of ventrals and by the disposition of rings. I consequently recognize the following subspecies:

### 1. MICRURUS CORALLINUS CORALLINUS (Wied)

*Diagnosis.*—Body red with single black annuli edged with whitish yellow; 14–26 annuli on the body in males and 17½–27 in females; 5–9 annuli on the tail in males and 4–6 in females; ventrals 186–207 in males and 198–221 in females.

*Type locality.*—San Francisco, Cabo Frio, and Parahyba, Brazil.

*Distribution.*—Found in southern, southeastern and central Brazil as well as in Uruguay, Argentina, Paraguay, Peru, and Venezuela.

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[12] Icon. Gen., 1872, pt. 42, pl. 6, fig. 2.

### 2. MICRURUS CORALLINUS RIISEI (Jan)

*Diagnosis.*—Body red with black annuli edged with whitish-yellow and sometimes also black (outer annuli), tail very dark so that the annuli become almost invisible; 25–30 annuli on the body in males and 22–31 in females; 9–12 annuli on the tail in males and 6–8 in females; ventrals 180–187 in males and 193–208 in females; anterior temporal with a marked tendency to disappear.

*Type locality.*—Trinidad.

*Distribution.*—Found in Trinidad and Venezuela. There is no evidence that it occurs in the islands of St. Vincent and St. Thomas as stated by Boulenger (p. 420).

### 3. MICRURUS CORALLINUS DUMERILII (Jan)

*Diagnosis.*—Body red with black annuli edged with yellow; outer black annuli practically always present; 10–19 annuli on the body in males and 12–19 in females; 5–11 annuli on the tail in males and 4–6 in females; ventrals 179–209 in males and 198–213 in females; posterior temporal with a tendency to be subdivided.

*Type locality.*—Cartagena, Colombia.

*Distribution.*—Found in Colombia and Ecuador.

## 37. MICRURUS LEMNISCATUS (Linnaeus)

*Coluber lemniscatus* LINNAEUS, Syst. Nat., ed 10., vol. 1, 1758, p. 224.
*Elaps lemniscatus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 430.
*Micrurus lemniscatus* AMARAL, Rev. Mus. Paulista, vol. 14, 1924, p. 3.
*Elaps ibiboboca* MERREM, Tent. Syst. Amph., 1820, p. 142.
*Elaps marcgravii* WIED, Nova Acta Acad. Leopold. Carol., vol. 10, pt. 1, 1820, p. 109.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 428.
*Micrurus ibiboboca* AMARAL, Revista Mus. Paulista, vol. 14, 1924, p. 4.

Very recently I revised[13] the nomenclatorial aspect of the mooted question regarding the names *M. lemniscatus* and *M. ibiboboca*. I am able now to say that the latter is a strict synonym of the former.

If we compare Boulenger's description of both his *M. lemniscatus* (*E. lemniscatus*) and *M. ibiboboca* (*E. marcgravii*) we find that the only point of distinction between these species consists in the number of ventrals and in the corresponding number of sets of black annuli. Boulenger's figures are as follows:

| | Ventrals | Sets of annuli |
|---|---|---|
| *M. lemniscatus* | 241–262 | 11–14 |
| *M. ibiboboca* | 210–240 | 6–10 |

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[13] Revista Mus. Paulista, vol. 14, 1924, pp. 3–6.

I believe that these figures are so definite because Boulenger had at his disposal only 23 specimens, which, of course, constitute a relatively small series. I, myself, having studied 13 specimens in the United States National Museum, was afterwards able to examine and compare 31 specimens in the Museum of Comparative Zoology and the large collection of the Instituto do Butantan, which I received in the meantime. The latter collection consisted of 58 specimens, thus making a total of 102 specimens. As a result I have ascertained that as a rule the female specimens have a larger number of ventrals, due to the fact that they have a larger number of dorsal vertebrae than the males, and that at the same time they usually have a larger number of annuli. This condition is particularly evident in large series of specimens, as, for instance, in that from Sao Paulo, Brazil, which is tabulated below.

*The 102 specimens examined were as follows:*

| Museum | No. | Locality | Sex | V. | C. | Triads of annuli | |
|---|---|---|---|---|---|---|---|
| | | | | | | Body | Tail |
| U. S. N. M. | 1405 | So. America | ♀ | 235 | 25 p.+ | 7 | 1+ |
| Do. | 5444 | Brazil | ♀ | 267 | 37 p. | 13 | 1⅔ |
| Do. | 6006 | Brazil (Amazonas) | ♀ | 249 | 39 p. | 10 | 1⅓ |
| Do. | 13823 | Dutch Guiana | ♀ | 237 | 38 p. | 14 | 1⅓ |
| Do. | 39074 | Brazil (S. Paulo) | ♀ | 234 | 30 p. | 12 | 1⅔ |
| Do. | 5585–1 | Trinidad | ♂ | 230 | 33 p. | 10 | 1⅔ |
| Do. | 5585–2 | do. | ♂ | 220 | 35 p.+2 | 10 | 1⅔ |
| Do. | 5585–3 | do. | ♂ | 214 | 32 p.+3 | 12 | 1⅔ |
| Do. | 7342 | do. | ♂ | 241 | 27 p.+7 | 10 | 1⅔ |
| Do. | 15234 | do. | ♂ | 225 | 34 p.+3 | 10 | 2 |
| Do. | 17740 | do. | ♂ | 220 | 30 p.+6 | 11 | 1⅔ |
| Do. | 55959 | do. | ♂ | 230 | 26 p. | 8 | 1⅔ |
| Do. | 60652 | do. | ♂ | 221 | 27 p.+5 | 10 | 2 |
| M. C. Z. | 6122 | do. | ♂ | 220 | 30 p. | 10 | 1⅔ |
| Do. | 6755 | do. | ♂ | 222 | 34 p.+2 | 10 | 1⅔ |
| Do. | 945–1 | So. America | ♂ | 234+½ | 40 p. | 11 | 1⅓ |
| Do. | 945–2 | do. | ♂ | 234+½ | 36 p.+2 | 10 | 1⅓ |
| Do. | 5066 | do. | ♂ | 213 | 24 p.+3 | 9 | 1⅓ |
| Do. | 9978 | Venezuela | ♂ | 208 | 29 p. | 12 | 1⅓ |
| Do. | 12428 | Peru | ♀ | 246 | 36 p. | 9 | 1⅔ |
| Do. | 9885 | Brazil (Amazonas) | ♂ | 235 | 42 p. | 12 | 1⅔ |
| Do. | 1208 | Brazil (Para) | ♂ | 221 | 35 p. | 9 | 1⅔ |
| Do. | 3216 | Brazil (Pernambuco) | ♀ | 236 | 22 p.+2 | 7 | 1⅓ |
| Do. | 1459 | do. | ♀ | 226 | 27 p. | 8 | 1⅓ |
| Do. | 3663–1 | Brazil (Bahia) | ♀ | 241 | 41 p. | 11 | 1⅔ |
| Do. | 3663–2 | do. | ♀ | 224 | 24 p. | 10 | 1⅓ |
| Do. | 1190–1 | do. | ♀ | 226 | 24 p. | 9 | 1⅓ |
| Do. | 1190–2 | do. | ♂ | 207 | 17 p.+5 | 8 | 1⅓ |
| Do. | 1357 | do. | ♂ | 220+½ | 22-p.+2 | 10 | 1⅓ |
| Do. | 1375 | Brazil (Rio) | ♂ | 233+½ | 26 p. | 10 | 1⅔ |
| Do. | 3298 | Brazil (Esp. Santo) | ♂ | 231 | 5 p.+18 | 11 | 1⅔ |
| Do. | 16433 | Brazil (Rio) | ♀ | 233 | 25 p. | 7 | 1⅓ |
| Do. | 1192–1 | do. | ♂ | 214 | 18 p.+6 | 9 | 1⅓ |
| Do. | 1192–2 | do. | ♂ | 227 | 23 p. | 8 | 1⅓ |
| Do. | 16683 | Brazil (S. Paulo) | ♂ | 235 | 33 p.+1 | 11 | 1⅓ |
| Do. | 2580 | Brazil (Para) | ♂ | 224 | 36 p. | 8 | 1⅓ |
| Do. | 2612 | do. | ♂ | 221+½ | 12 p.+12 | 8 | ⅓ |
| Do. | 2955–1 | Brazil (Bahia) | ♂ | 232 | 26 p.+1 | 7 | 1⅓ |
| Do. | 2955–2 | do. | ♂ | 227 | 25 p. | 7 | 1⅓ |
| Do. | 2976 | Brazil (Amazonas) | ♂ | 218 | 13 p.+8 | 6 | ⅓ |
| Do. | 17762 | Brazil (Minas) | ♂ | 232 | 36 p. | 12 | 1⅔ |
| Do. | 17761 | do. | ♀ | 258 | 28 p. | 12 | 1⅔ |
| Do. | 17851 | Brazil (Bahia) | ♂ | 224 | 25 p. | 8 | 1⅓ |
| Do. | 17852 | Brazil (Minas) | ♂ | 235 | 27 p.+3 | 11 | 1⅔ |
| Inst. Butantan | 1308 | Brazil (S. Paulo) | ♀ | 241 | 30 p. | 15 | 2 |
| Do. | 1593 | do. | ♂ | 240 | 35 p. | 12 | 1⅔ |
| Do. | 937 | do. | ♂ | 225 | 32 p. | 12 | 1⅔ |
| Do. | 1528 | do. | ♂ | 226 | 31 p. | 11 | 2 |
| Do. | 1544 | do. | ♂ | 230 | 27 p.+2 | 13 | 2 |
| Do. | 1728 | Brazil (Amazonas) | ♀ | 246+½ | 41 p. | 10 | 1⅔ |

*The 102 specimens examined were as follows*—Continued

| Museum | No. | Locality | Sex | V. | C. | Triads of annuli | |
|---|---|---|---|---|---|---|---|
| | | | | | | Body | Tail |
| Inst. Butantan | 1706 | Brazil (S. Paulo) | ♂ | 233 | 32 p. | 11 | 1⅔ |
| Do. | 1220 | do. | ♀ | 254 | 28 p.+1 | 16 | 2 |
| Do. | 1613 | do. | ♂ | 233 | 32 p. | 13 | 1⅔ |
| Do. | 1592 | do. | ♂ | 234 | 36 p. | 13 | 2 |
| Do. | 900 | do. | ♂ | 230+$\frac{5}{2}$ | 31 p. | 13 | 2 |
| Do. | 1020 | do. | ♀ | 256 | 32 p. | 12 | 2 |
| Do. | 598 | Brazil (Minas) | ♂ | 241 | 30 p. | 11 | 1⅔ |
| Do. | 1221 | Brazil (S. Paulo) | ♀ | 253 | 33 p. | 17 | 2 |
| Do. | 1198 | do. | ♂ | 234 | 28 p. | 13 | 2 |
| Do. | 1044 | do. | ♂ | 233 | 38 p. | 13 | 2 |
| Do. | 382 | do. | ♀ | 264 | 30 p. | 18 | 2 |
| Do. | 381 | do. | ♂ | 251 | 30 p. | 15 | 1⅔ |
| Do. | 869 | Brazil (Bahia) | ♂ | 247 | 41 p. | 12 | 2 |
| Do. | 965 | do. | ♀ | 259 | 28 p. | 11 | 1⅔ |
| Do. | 1300 | Brazil (S. Paulo) | ♂ | 234 | 33 p. | 12 | 2 |
| Do. | 409 | do. | ♂ | 234 | 33 p. | 12 | 2 |
| Do. | 1821 | do. | ♀ | 246 | 32 p.+3 | 14 | 2 |
| Do. | 1182-A | do. | ♂ | 230 | 33 p. | 12 | 1⅔ |
| Do. | 1354 | Brazil (Bahia) | ♂ | 226 | 23 p.+4 | 10 | 1⅓ |
| Do. | 1729 | Brazil (Amazonas) | ♂ | 226 | 28 p.+ | 8 | 1+ |
| Do. | 1050 | Brazil (Ceara) | ♂ | 231 | 26 p. | 9 | 1⅓ |
| Do. | 969 | Brazil (Bahia) | ♂ | 227 | 24 p. | 9 | 1⅓ |
| Do. | 485 | Brazil (Piauhy) | ♂ | 232 | 26 p. | 10 | 1⅓ |
| Do. | 1281 | do. | ♂ | 238 | 26 p. | 9 | 1⅓ |
| Do. | 484 | do. | ♀ | 233 | 20 p.+4 | 9 | 1⅓ |
| Do. | 498 | do. | ♂ | 236 | 22 p. | 8 | 1⅓ |
| Do. | 508 | do. | ♂ | 232 | 22 p.+3 | 9 | 1⅓ |
| Do. | 1663 | do. | ♂ | 234 | 24 p. | 9 | 1⅓ |
| Do. | 1311 | Brazil (Ceara) | ♂ | 222 | 24 p. | 9 | 1⅓ |
| Do. | 75 | Brazil (Bahia) | ♀ | 229 | 18 p.+6 | 9 | 1⅓ |
| Do. | 1753 | do. | ♀ | 230 | 24 p. | 11 | 1⅓ |
| Do. | 982 | do. | ♂ | 226 | 24 p. | 9 | 1⅓ |
| Do. | 981 | do. | ♂ | 230 | 24 p. | 11 | 1⅓ |
| Do. | 986 | do. | ♂ | 219 | 24 p. | 9 | 1⅓ |
| Do. | 1410 | do. | ♂ | 213 | 22 p.+4 | 9 | 1 |
| Do. | 1850 | Brazil (S. Paulo) | ♂ | 205 | 13 p.+10 | 9 | 1⅓ |
| Do. | 3040 | Brazil (Bahia) | ♀ | 263 | 37 p. | 11 | 1⅔ |
| Do. | 3041 | Brazil (S. Paulo) | ♂ | 226+½ | 35 p. | 11 | 1⅔ |
| Do. | 3042 | do. | ♀ | 234 | 34 p. | 13 | 1⅔ |
| Do. | 3043 | do. | ♀ | 234 | 30 p.+2 | 14 | 2 |
| Do. | 3044 | do. | ♀ | 255 | 30 p. | 14 | 1⅔ |
| Do. | 3045 | do. | ♀ | 243 | 32 p. | 16 | 2 |
| Do. | 3046 | do. | ♀ | 238 | 35 p. | 14 | 2 |
| Do. | 3047 | do. | ♀ | 235 | 28 p.+4 | 16 | 2 |
| Do. | 3048 | do. | ♂ | 219 | 30 p.+2 | 14 | 2⅓ |
| Do. | 3049 | do. | ♀ | 252 | 27 p. | 13 | 2 |
| Do. | 3050 | do. | ♀ | 229 | 30 p.+2 | 12 | 2 |
| Do. | 3051 | do. | ♂ | 260 | 30 p. | 14 | 1⅔ |
| Do. | 3052 | do. | ♀ | 233 | 33 p. | 12 | 2 |
| Do. | 3053 | do. | ♂ | 243 | 29 p. | 11 | 1⅓ |
| Do. | 3054 | do. | ♀ | 260 | (Injured tail.) | 14 | ? |
| Do | 3055 | Brazil (Minas) | ♂ | 238 | 29 p. | 14 | 2 |

Summarizing the above data according to both sex and geographical distribution of the various specimens, the following averages have been found:

| Locality | Number of specimens | Sex | V | C | Triads of annuli | |
|---|---|---|---|---|---|---|
| | | | | | Body | Tail |
| 1. So. America | 3 | ♂♂ | 213 –234+½ | 27–40 p. | 9–11 | 1⅓ |
| | 1 | ♀ | 235 | 25 p.+ | 7 | 1+ |
| 2. Trinidad | 10 | ♂♂ | 214 –241 | 26–40 p. | 8–12 | 1⅔–2 |
| 3. Venezuela | 1 | ♂ | 208 | 29 p. | 12 | 1⅓ |
| 4. Dutch Guiana | 1 | ♀ | 237 | 38 p. | 14 | 1⅓ |
| 5. Peru | 1 | ♀ | 246 | 36 p. | 9 | 1⅔ |
| 6. Brazil | 1 | ♀ | 267 | 37 p. | 13 | 1⅔ |
| (*a*) Amazonas | 3 | ♂♂ | 218 –235 | 21–42 p. | 6–12 | ⅓–1⅔ |
| | 2 | ♀♀ | 246½ –249 | 39–41 p. | 10–14 | 1⅓–1⅔ |
| (*b*) Para | 3 | ♂♂ | 221 –224 | 24–36 p. | 8– 9 | ⅔–1⅔ |
| (*c*) Piauhy | 4 | ♂♂ | 232 –238 | 24–26 p. | 9–10 | 1⅓ |
| | 2 | ♀♀ | 233 –236 | 22–24 p. | 8– 9 | 1⅓ |
| (*d*) Ceara | 2 | ♂♂ | 222 –231 | 24–26 p. | 9 | 1⅓ |
| (*e*) Pernambuco | 2 | ♀♀ | 226+½–236 | 24–27 p. | 7– 8 | 1⅓ |
| (*f*) Bahia | 12 | ♂♂ | 207 –247 | 22–41 p. | 7–12 | 1 –2 |
| | 7 | ♀♀ | 226 –263 | 24–41 p. | 9–11 | 1⅓–1⅔ |
| (*g*) Esp. Santo | 1 | ♂ | 231 | 23 p. | 11 | 1⅔ |
| (*h*) Rio | 3 | ♂♂ | 214 –233+½ | 23–26 p. | 8–10 | 1⅓–1⅔ |
| | 1 | ♀ | 233 | 25 p. | 7 | 1⅓ |
| (*i*) Minas | 4 | ♂♂ | 232 –241 | 29–36 p. | 11–14 | 1⅓–2 |
| | 1 | ♀ | 258 | 28 p. | 12 | 1⅔ |
| (*j*) S. Paulo | 20 | ♂♂ | 205 –243 | 23–41 p. | 9–14 | 1⅓–2⅓ |
| | 17 | ♀♀ | 234 –264 | 27–35 p. | 12–18 | 1⅔–2 |
| General average | 66 | ♂♂ | 205 –247 | 21–42 p. | 5–14 | ⅓–2⅓ |
| | 36 | ♀♀ | 226 –267 | 22–41 p. | 7–18 | 1⅔–2 |

On the basis of the study of these 102 specimens I am now able to redescribe the species as follows:

### MICRURUS LEMNISCATUS (Linnaeus)

Eye about two to three fifths its distance from the oral margin. Rostral wider than deep; frontal as wide as or much wider than the supraocular, once and a half to twice as long as wide, as long as its distance from the end of the snout, shorter than the parietals, which are longer than their distance from the internasals; one prae—and two postoculars; temporals 1+1, anterior usually much longer and narrower than posterior; seven upper labials, third much larger than fourth, third and fourth entering the orbit; four lower labials in contact with the anterior chin-shields which are about as long as the posterior. Scales in 15 rows. Ventrals 205–247 in males, 226–267 in females; anal divided; subcaudals 21–42. Body red with triads of black annuli, subequal or the middle a little wider; 6–14 triads on the body in males, 7–18 in females; usually 1–2 triads on the tail; black annuli separated by light yellow ones which may be spotted or dotted with black or only have black-edged scales; head red (yellow sometimes in preserved specimens), with two transverse black bands, one on the snout and another across the frontal region; sometimes one or two small spots on the occiput or head-shields black, edged with yellow.

Total length—1450 mm.[14]; tail 100 mm.

Found in Tropical South America: Trinidad, Venezuela, Guianas, Ecuador, Bolivia, Peru, N. Paraguay, N. Argentina [15], and especially in Brazil, where, however, it never occurs in the south beyond the State of Sao Paulo.

### 88. BOTHROPS ATROX (Linnaeus)

*Coluber atrox* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 222.

*Lachesis lanceolatus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 535 (in part).—BRAZIL, La Défence contre l'Ophidisme, 1914, p. 84 (part).

*Lachesis atrox* BOULENGER, p. 537 (part).—BRAZIL, La Défence contre l'Ophidisme, 1914, p. 84.—AMARAL, Ann. Mem. Inst. Butantan, vol. 1, pt. 1, 1921, pp. 34 and 78.

*Bothrops atrox* AMARAL, Copeia, No. 126, 1924, p. 19; Rev. Mus. Paulista, vol. 14, 1924, p. 39.

Panama.—3 specimens.

Colombia.—1 specimen.

Ecuador.—A large series of specimens all having short and high keels on the scales.

Peru.—1 specimen.

Martinique.—5 specimens.

Santa Lucia.—4 specimens.

Tobago.—2 specimens.

Trinidad.—5 specimens.

French Guiana.—1 specimen.

Brazil.—5 specimens.

Paraguay (accidentally).—1 specimen.

All these specimens will be referred to in a more elaborate report I am at present writing on the differences between the 3 species of Neotropical Crotalidae, *B. atrox* (Linnaeus, 1758), *B. jararaca* (Wied, 1824) and *B. jararacussu* Lacerda, 1884.

### 89. BOTHROPS JARARACA (Wied)

*Cophias jararaca* WIED, Isis, 1824, pt. 2, p. 1103; Abbild. Naturg. Brasil., 1824, p. 7.

*Lachesis lanceolatus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 535 (part).

*Lachesis jararaca* AMARAL, Ann. Mem. Inst. Butantan, vol. 1, pt. 1, 1921, p. 34.

*Bothrops jararaca* AMARAL, Copeia, vol. 126, 1924, pp. 19 and 78.

Brazil.—1 specimen, No. 40216 collected in Santa Catharina by Mr. Ehrhardt.

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[14] Specimen No. 1308 Inst. Butantan, sent alive, from the locality Ventania, State of S. Paulo, in July, 1917, by Goncalves de Freitas.

[15] Serie in his "Catalogo de los Ofidios Argentinos" states that this species is found from the Rio Negro and Central Pampa to the North.

### 90. BOTHROPS PICTA (Tschudi)

*Lachesis picta* TSCHUDI, Fauna Peruv., Herp., 1845, p. 61, pl. 10.
*Bothrops pictus* JAN, Elenco Sist., 1863, p. 126.
*Lachesis pictus* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 540.

Peru.—1 specimen, No. 49992 collected in Lima by C. H. T. Townsend on April 26, 1913: lab. 9, 2d entering the loreal pit; sc. 25; v. 167; c. 47 p.

### 91. BOTHROPS NEUWIEDI Wagler

*Bothrops neuwiedi* WAGLER, in Spix, Species Novae Serp. Brasil., vol. 56, 1826, pl. 22, fig. 1.
*Lachesis neuwiedii* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 542.

Argentina.—1 specimen, No. 12380, collected at Rio Vermejo, by the La Plata Expedition.

### 92. BOTHROPS LEPTURA Amaral

*Bothrops leptura* AMARAL, Proc. New England Zool. Club, vol. 8, 1923, p. 102 (type from Cana, Eastern Panama).

Ecuador.—2 specimens, both collected by M. B. Kerr: No. 20629, sc. 27; v. 201; c. 82 p.; no scale separating the internasals from each other; upper head scales rugose; tail unspotted beneath, light posteriorly and with a few dark blotches anteriorly; total length 430 mm.; tail 75 mm. No. 20630: sc. 28; v. 198; c. 87 p.; head scales as in No. 20629; tail, anteriorly slightly blotched with dark above and powdered with dark beneath, posteriorly light, unspotted; total length 1,120 mm.; tail 185 mm.

### 93. BOTHROPS LANSBERGII (Schlegel)

*Trigonocephalus lansbergii* SCHLEGEL, Mag. Zool., 1841, Rept., pl. 1.
*Bothrops lansbergi* JAN, Elenco Sist., 1863, p. 127.
*Lachesis lansbergii* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p .546.

Venezuela.—1 specimen, female, No. 61225, collected at the Sierra de Perija, by Theo. de Booy: sc. 25; v. 154; c. 29; rostral 1½ as deep as wide.

### 94. BOTHROPS BRACHYSTOMA (Cope)

*Teleuraspis castelnaui*, var. *brachystoma* COPE, Proc. Acad. Nat. Sci., Philadelphia, 1859, p. 339.
*Bothrops brachystoma* BOCOURT, Journ. Zool., vol. 5, 1876, p. 410.
*Lachesis brachystoma* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 547.

Ecuador.—5 specimens, all collected by M. B. Kerr:

| U. S. N. M. number | Sex | Sc. | V. | C. | Rostral (depth by width) |
|---|---|---|---|---|---|
| 20, 625 | ♂ | 23 | 133 | 34 | 2×1 |
| 20, 626 | ♀ | 23 | 131 | 34 | 2×1 |
| 20, 627 | ♀ | 24 | 135 | 28 | 2×1 |
| 20, 628 | ♀ | 23 | 134 | 28 | 2×1 |
| 22, 442 | ♀ | 23 | 128 | 29 | 2×1 |

### 95. BOTHROPS SCHLEGELII (Berthold)

*Trigonocephalus schlegelii* BERTHOLD, Abh. Ges. Wiss. Goettingen, vol. 3, 1846, p. 13, pl. 1, figs. 5–6.
*Bothrops schlegeli* JAN, Elenco Sist., 1863, p. 127.
*Lachesis schlegelii* BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 567.

### 96. CROTALUS TERRIFICUS (Laurenti)

*Caudisona terrifica* LAURENTI, Syn. Rept., 1768, p. 93.
*Crotalus terrificus* COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 688.—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 574.

Paraguay.—4 specimens, No. 11262 (head) and 3 young ones, No. 11258, all collected by Dr. E. Palmer.

### 97. LACHESIS MUTUS (Linnaeus)

*Crotalus mutus* LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 373.
*Lachesis mutus* DAUDIN, Hist. Nat. Rept., vol. 5, 1803, p. 351.—BOULENGER. Cat. Snakes Brit. Mus., vol. 3, 1898, p. 534.
*Lachesis stenophrys* COPE, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 534.

Ecuador.—1 specimen (head), No. 20635, sent by Mark B. Kerr.

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# FORAMINIFERA OF THE GENERA SIPHOGENERINA AND PAVONINA

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By Joseph A. Cushman
*Of Sharon, Massachusetts*

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Continued study of various collections of Foraminifera, largely brought together through governmental agencies, has rendered it both possible and advisable to present at this time a revision of two genera of Foraminifera and their component species, the Genus Siphogenerina Schlumberger, and Pavonina d'Orbigny.

## GENUS SIPHOGENERINA SCHLUMBERGER

There seems to be some hestitation on the part of certain workers on the Foraminifera to make use of the generic name *Siphogenerina.* Instead of using it the generic name *Sagrina* is often used. A study of West Indian material has made possible the clearing up of the questions relating to these two generic names. A review of much of the literature, and of species so far as specimens are available, has given some very definite information as to distribution.

The type species of d'Orbigny's genus *Sagrina* is *S. pulchella* d'Orbigny.[1]. The description and figure are very definite. The generic description freely translated is as follows: "Test free, regular, equilateral, conical, chambers globular, regularly alternating at all stages on each side of the longitudinal axis, partially overlapping; aperture rounded, above the last-formed chamber at the end of an elongate neck." The similarity to *Textularia* is also noted. The other species from the Chalk of the Paris Basin, *S. rugosa* d'Orbigny,[2] is of similar character.

Little further note is made of *Sagrina* until in 1865 Parker and Jones [3] emended it, and used it in a subgeneric sense under *Uvigerina* to include *diaphanus, dimorpha,* and *nodosa.* Their work was followed by subsequent authors. The type of d'Orbigny is referred to as follows (p. 364): "D'Orbigny has figured under the name of *Sagrina pulchella* (Foram. Cuba, pl. 1, figs. 23, 24) a specimen which was either the young, or an arrested individual of such a biformed *Uvigerina,*" and also: "Not only is our Nodosariform *Uvigerina*

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[1] De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 150, pl. 1, figs. 23, 24.

[2] Mém. Soc. géol. France, vol. 4, 1840, p. 47, pl. 4, figs. 31, 32.

[3] Philos. Trans., vol. 155, p. 363.

No. 2597.—Proceedings U. S. National Museum Vol. 67, Art. 25.

connected with the typical *U. pygmaea* (figs. 53–56) through *Sagrina pulchella,* D'Orb., but an intermediate condition between it and the feebler dimorphs of the Mediterranean area occurs in the mud brought up by the sounding lead from the Abrohlos Bank (*U. dimorpha*)." "Altogether this latter group of forms shows how great the affinity is between the always hyaline *Uvigerina* and the porous sandy *Textularia.*"

Brady in the *Challenger* Report notes the relationships of both *Sagrina pulchella* and *S. rugosa* to the Textulariidae.

A study of collections from the West Indies and the coast of Florida has shown conclusively that the *Sagrina pulchella* of d'Orbigny is in reality a *Bolivina* which is widely distributed in that general region. The peculiar apertural characters with the sides somewhat raised could have easily been mistaken for the sort of aperture in d'Orbigny's figure, if the specimen were not seen from the end. With *S. pulchella* really a species of *Bolivina,* and as Brady notes *S. rugosa* is related to *Gaudryina* it follows that *Sagrina,* if used at all, must be used for species belonging to the Textulariidae. As the type species is a *Bolivina* the name *Sagrina* can not be used unless for a part of that genus.

The first name that can be taken up for the generic characters of the species noted by Parker and Jones is *Siphogenerina* Schlumberger. Schlumberger called attention to the internal structure, and erected the genus *Siphogenerina* based on the tubular connecting interior.[4] The genus is related to *Uvigerina* and *Trifarina* (*Triplasia* or *Rhabdogonium*) and to the group of the Lagenidae with apertures exserted, with a tubular neck and phialine lip.

### Genus SIPHOGENERINA Schlumberger, 1883

*Sagrina* PARKER and JONES (not d'Orbigny), Philos. Trans., vol 155, 1865, p. 363.—H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 580.—CHAPMAN, The Foraminifera, 1902, p. 201.

*Dimorphina* SCHWAGER (not d'Orbigny), Novara-Exped., Geol. Theil., vol. 2, 1866, p. 251.

*Siphogenerina* SCHLUMBERGER (type, *S. raphanus* (Parker and Jones)), Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 117.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 104; Bull. 104, pt. 4, 1923, p. 172.

*Description.*—Test elongate, composed at least in the microspheric form of a series of chambers arranged tri or bi serially, followed by a later uniserial development; walls hyaline and perforate; aperture in the uniserial portion central and terminal, usually with an elongated neck and flaring lip; interior of the chamber with a tubular connection running from the base of the apertural neck to the lip of the aperture below; wall smooth or ornamented by costae, pits, etc.

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[4] Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 117.

Both microspheric and megalospheric forms occur in the various species of this genus. In the microspheric form the early chambers are biserial or triserial, and there is usually a considerable number of them before the adult uniserial development takes place. In the megalospheric form the uniserial condition is taken on much earlier, after only a few of the triserial or biserial chambers are developed.

In the present ocean the species are found in the Indo-Pacific most abundantly, but also in the Western Atlantic and the Mediterranean. In the fossil condition the genus occurs in the Tertiary as noted under the various species.

Halkyard in his paper edited by Heron-Allen and Earland[5] places *Siphogenerina* as a subgenus of *Bigenerina.* The relationships, however, seen to be with *Uvigerina* and the Lagenidae. In microspheric specimens of *Siphogenerina bifrons* the early chambers sometimes show a decidedly coiled character, linking the early development of *Siphogenerina* with coiled forms like that of *Cristellaria.*

A rough key is given to the species of the genus treated here:

### A KEY TO THE SPECIES OF SIPHOGENERINA

Test not compressed:
Costate—
Costae few and prominent—
Costae more prominent than suture lines—
Test large and fusiform ---------- S. collomi
Test tapering throughout—
Costae high, lamellate—
Costae 10 or less ---------- S. raphanus
Costae 15 or more ---------- S. reedi
Costae, low, not lamellate ---------- S. kleinpelli
Costae less prominent than suture lines ---------- S. branneri
Costae numerous and prominent—
Neck short ---------- S. striata, var. curta
Neck long and slender ---------- S. irregularis
Costae very numerous, not prominent ---------- S. striatula
Lamellate—
Lamellae very prominent, not spinose ---------- S lamellata
Lamellae less prominent, spinose near base ---------- S. spinosa
Smooth—
Test slender and elongate ---------- S. columellaris
Test short and stout ---------- S. hughesi
Coarsely punctate ---------- S. dimorpha
Spinose or hispid ---------- S. virgula
Slender, early portion costate, middle spinose, later part smooth - S. mexicana
Test compressed:
Short, stout, sides deeply depressed ---------- S. bifrons
Elongate, slender, sides not depressed ---------- S. advena

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[5] Mem. Proc. Manchester Lit. Philos. Soc., vol. 62, pt. 2, 1919, p. 37.

### SIPHOGENERINA RAPHANUS (Parker and Jones)

Plate 1, figs. 1–4; plate 2, figs. 1–3, 10; plate 5, figs. 1, 2

*Uvigerina* (*Sagrina*) *raphanus* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 364, pl. 18, figs. 16, 17.

*Sagrina raphanus* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 585, pl. 75, figs. 21–24.—WOODWARD, The Observer, 1893, p. 144.—CHAPMAN, Journ. Linn. Soc., vol. 28, 1900, pp. 187, 208; 1902, p. 403.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 272.—DAKIN, Rep. Ceylon Pearl Oyster Fish., vol. 5, 1906, p. 236, pl., fig. 11.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 415.—SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 88.—HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 677.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 148.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 186; Journ. Linn. Soc. Zool., vol. 35, 1924, p. 627.

*Siphogenerina* (*Sagrina*) *raphanus* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 317, pl. 9, fig. 36.

*Siphogenerina raphanus* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 108, pl. 46, figs. 1–5; Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 280, pl. 56, fig. 7; Publ. 311, Carnegie Inst. Washington, 1922, p. 35, pl. 5, fig. 5; Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 174, pl. 42, fig. 14.—YABE and HANZAWA, Jap. Journ. Geol. Geog., vol. 2, No. 2, 1923, p. 32; vol. 2, No. 4, 1923, p. 103.—CUSHMAN, Publ. 342, Carnegie Inst. Washington, 1924, p. 28, pl. 8, figs. 1, 2.

*Siphogenerina raphanus* (PARKER and JONES), var. *costulata* CUSHMAN, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 662; Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 281, pl. 56, fig. 6.

*Siphogenerina costata* SCHLUMBERGER, Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 118, fig. 13.

Test elongate, cylindrical or tapering, chambers of the uniserial portion broader than long; surface marked by several rather widely separated, well-developed costae, each extending nearly the length of the test, independent of the sutures; aperture typically with a short tubular neck and well-developed flaring lip.

Length around 1 mm.

*Distribution.*—Parker and Jones when they described this species had specimens from the following localities: "West Indies, Panama, India (on clam-shell), Bombay Harbour (anchor-mud), Hong Kong (anchor-mud), Australian Coral-reefs (17 fathoms)." In the *Challenger* Report Brady gives the following records: "shore sands, Bermuda, West Indies, Panama, and Madagascar; anchor-mud, Port Louis, Mauritius; dredged sands, off Calpentyn, Ceylon, 2 fathoms, off Kerguelen Island, 12 fathoms, off the Philippines, 95 fathoms, off Honolulu, Sandwich Islands, 40 fathoms; and at fifteen stations amongst the islands of the South Pacific, at depths ranging from 2 fathoms to 260 fathoms." Egger records it also from off Mauritius. Chapman had it from numerous stations about Funafuti, some of which are in deep water, the greatest depth 2,728 fathoms. He also found it common from shallow depths in the lagoon to 300 fathoms outside the reef. Millett records both microspheric and megalospheric specimens from the Malay region. Heron-Allen and Earland had it from five stations in their Kerimba Archipelago collections. Dakin records it as "sparingly," Gulf of Manaar. Sidebottom's specimens are from 465 fathoms off the East Coast of Australia. Heron-Allen and Earland record it from the Antarctic Expedition material dredged by the *Terra Nova* off Three Kings Island, New Zealand, 90–120 fathoms and from Lord Howe Island in the Pacific. I have had it from the Pacific from off Japan in 44 and 361 fathoms, between Yokohama and Guam in 1,208 fathoms, and in 271 fathoms off the Hawaiian Islands. It occurred at several stations in the Samoan collections, most common at the deepest station, 50 fathoms, and at numerous stations in the Philippine region, 78–554 fathoms.

In the Atlantic it is rare, and the only records are from the western tropical portions. It occurred rarely but well developed in the shallow-water material from the Tortugas region, and at a single *Albatross* station off Central America in 382 fathoms.

There are very few records of its occurrence in the fossil state. Schubert records it from the "Neogene" of Sanaibas, in the Bismarck Archipelago, and from a "coral-sand" probably Pleistocene of Maria Island in the Paumotu group. Yabe and Hanzawa record it as rare from the Pliocene shell beds of Nojima, and as rare at Nagamura, Japan. Heron-Allen and Earland record a questionable specimen from New Zealand of sub-fossil character. Halkyard[6] records the species from the Eocene Blue Marl of Biarritz. The editors of Halkyard's paper, Heron-Allen and Earland, make the following note as to these specimens. "They are much longer and narrower than any specimens of *S. raphanus* that we have ever seen, and there is no evidence of any uvigerine commencement. We should have ascribed them with little hesitation to *Nodosaria obliqua* (Linne)." This then removes from consideration this Eocene material which is so far out of the known range of the species.

The species is in its typical form one of characteristic distribution, mainly Indo-Polynesian, ranging from the Kerimba Archipelago across the Indian Ocean, extending northward to Japan, Guam, and the Hawaiian Islands, and southward to New Zealand. It also extends into the western tropical Atlantic, but seems to be rare. As a fossil it occurs in the late Tertiary of Japan and the Bismarck Archipelago.

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[6] Mem. Proc. Manchester Lit. Philos. Soc. vol., 62, 1919, p. 38.

### SIPHOGENERINA RAPHANUS (Parker and Jones), var. TROPICA, new variety

Plate 1, fig. 5; plate 5, figs. 7, 8

*Description.*—Variety differing from the typical in the shape of the test, which is tapering, wall thicker, the sutures less distinct, and the apertural end with a definite neck and flaring phialine lip.

This is the variety figured by Brady in the *Challenger* Report[7] and which I have figured.[8]

This variety so far as known is confined to the Pacific in shallow water about coral reefs. Type specimens are from *Albatross* D 5178 in 78 fathoms near Romblon.

### SIPHOGENERINA RAPHANUS (Parker and Jones), var. TRANSVERSUS Cushman

Plate 1, fig. 6

*Siphogenerina raphanus* (PARKER and JONES), var. *transversus* CUSHMAN, Bull. 103, U. S. Nat. Mus., 1918, p. 64, pl. 22, fig. 8.

*Description.*—Test subcylindrical, composed of comparatively few chambers, the earlier ones spirally arranged, later and greater portion of the test uniserial, sutures very prominently indented, between the longitudinal costae which are few in number; aperture with a short cylindrical neck, lip not evident.

Length of type specimen 1.25 mm.; breadth 0.54 mm.

This variety was originally described from the Culebra formation of the Panama Canal Zone in dark clay, north of Pedro Miguel Locks. I have material of this same variety from Brasso, Trinidad, British West Indies, collected by F. W. Penny.

This is related to *S. kleinpelli* Cushman, but the costae are fewer and stronger, and the indented portions below the sutures deeper.

### SIPHOGENERINA COLLOMI Cushman

*Siphogenerina collomi* CUSHMAN, Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 2, pl. 4, fig. 3.

Test large for the genus, fusiform, greatest width above the middle; early chambers irregularly spiral, later ones uniserial, distinct; sutures depressed, strongly curved, extending back on the costae to a considerable distance; test ornamented with very high, plate-like costae, usually ten in number, last-formed chamber smooth; aperture with a very short cylindrical neck and phialine lip.

Length up to 1.60 mm.; breadth 0.65 mm.

Type specimens (Cushman Coll. No. 4325) from Monterey shale, sec. 24, T. 28 S., R. 14 E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This species is nearest related to *Siphogenerina spinosa* Bagg from the Miocene of Maryland and *S. lamellata* Cushman from the Miocene of Florida. The species is named for Roy E. Collom, well-known geologist of California.

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[7] Pl. 75, figs. 23, 24.

[8] Bull. 100, U. S. Nat. Mus., vol. 4, 1900, pl. 56, fig. 7.

### SIPHOGENERINA REEDI Cushman

*Siphogenerina reedi* CUSHMAN, Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 3, pl. 4, fig. 4.

Test about twice as long as broad, greatest breadth at the apertural end, thence gradually tapering to the initial end; chambers distinct; sutures somewhat depressed, strongly curved; wall ornamented with about fifteen lamellate costae which may continue onto the last-formed chamber; apertural characters obscure.

Length up to 1.10 mm.; breadth 0.50 mm.

Type specimens (Cushman Coll. No. 4326) from Monterey shale, sec. 24, T. 28 S., R. 14 E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This may be distinguished from *S. collomi* by its smaller size and greater number of costae. It is nearest the form I have described from the Panama Canal Zone as *S. raphanus* (Parker and Jones), var. *transversus* Cushman.

It is named for Ralph D. Reed, geologist of California, under whose direction the material was collected.

### SIPHOGENERINA KLEINPELLI Cushman

*Siphogenerina kleinpelli* CUSHMAN, Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 3, pl. 4, fig. 5.

Test about twice as long as broad, greatest breadth at the apertural end, thence irregularly tapering to the initial end; chambers distinct; sutures depressed, very slightly if at all curved; wall ornamented with about fifteen very low costae, not at all lamellate, not continuing onto the last-formed chamber; aperture with a very short cylindrical neck and slight phialine lip.

Length up to 1 mm.; breadth 0.50 mm.

Type specimens (Cushman Coll. No. 4327) from Monterey shale, sec. 24, T. 28 S., R. 14 E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This species may be distinguished from *S. reedi* by the much lower and less prominent costae, and the lack of curvature in the sutures.

It is named for W. D. Kleinpell who collected the material.

### SIPHOGENERINA BRANNERI (Bagg)

Plate 1, figs. 7–9; plate 4, fig. 7

*Sagrina branneri* BAGG, Bull. 268, U. S. Geol. Surv., 1905, p. 40, pl. 7, fig. 4.

*Sagrina californiensis* BAGG, Bull. 268, U. S. Geol. Surv., 1905, p. 41, pl. 7, fig. 5.

*Sagrina elongata* BAGG, Bull. 268, U. S. Geol. Surv., 1905, p. 41, pl. 7, fig. 6

*Description.*—Test subcylindrical, the microspheric form tapering, the megalospheric fusiform; chambers numerous, inflated; sutures distinct, slightly depressed; surface ornamentation consisting of numerous distinct, slightly raised, longitudinal costae, the chamber at the sutures continued backward along these costae giving a scalloped edge to the suture; aperture with a short, cylindrical neck and narrow phialine lip.

Length of microspheric form up to 2.6 mm.

*Distribution.*—This species is common in the Miocene of California. It was described from the Monterey shale, on the Ranchodel Encinal, 7,000 feet south of Asuncion station, San Luis Obispo County, California. The outcrop is on Graves Creek.

Three species were described by Bagg from this material. The first of these, *S. branneri*, is the microspheric form of the species, the other two, *S. californiensis* and *S. elongata*, represent the megalospheric form. I have material from the type locality.

### SIPHOGENERINA STRIATA (Schwager), var. CURTA, new variety

Plate 2, fig. 5; plate 5, figs. 5, 6

*Sagraina striata* H. B. BRADY (not Schwager), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 584, pl. 75, figs. 25, 26.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 272.—DAKIN, Rep. Ceylon Pearl Oyster Fisheries, vol. 5, 1906, p. 236.

*Siphogenerina* (*Sagrina*) *striata* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 316, pl. 9, figs. 32, 34, 35, 64, 65 [?].

*Siphogenerina striata* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 107, pl. 47, figs. 4, 5; Bull. 100, vol. 4, 1921, p. 280, pl. 56, fig. 5.

*Description.*—Test elongate, cylindrical, chambers of the uniserial portion broader than long; sutures not deep but conspicuous; wall ornamented by longitudinal costae, not close together and not prominent; aperture circular with no neck but a prominent rounded lip.

Length up to 1 mm.

*Distribution.*—Schwager originally described this species from the Pliocene of Kar-Nicobar.[9] His original figure shows a slender test with an elongate neck. Recent specimens have practically no neck and are stouter than the typical form. Whether they represent a new species or a variety of Schwager's species is a question. Brady's specimens were of this varietal form. His records are "off the coast of South America, south of Pernambuco, 350 fathoms; shore-sand, east coast of Madagascar; off Kandavu, Fiji Islands, 210 fathoms; off New Hebrides, 125 fathoms; Torres Strait, 3 to 11 fathoms; off Ki Islands, 129 fathoms; and off the Philippines, 95 fathoms." Millett's records are from the Malay Archipelago and Dakin's from Ceylon, both probably based on Brady's figures. Egger's records are dubious. I have had this varietal form from off Hawaii, 114 fathoms: off Guam, 234 fathoms: southeast of the Bonin Islands in

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[9] *Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 251, pl. 7, fig. 99.

1,618 fathoms, and from nine stations in the Philippine region, ranging in depths from 78 to 554 fathoms.

Heron-Allen and Earland record the species from the Kerimba Archipelago [10] as follows:

> At Stn. 10 the specimens are of a regular type, cylindrical in section, similar to Brady's figures. At Stn. 11 the specimens are large, oval in section, and characterized by a bifarine arrangement of the middle chambers, the septa, which are limbate, running in a zigzag direction. The shells thus appear to present a transition type between *S. striata* and *S. bifrons* Brady.

The figured specimens from the Kerimba region show specimens which seem to belong to *Bolivina* or *Bifarina* and not to *Siphogenerina*, nor do they suggest *S. bifrons*, which is a very well characterized species, even though it has a striate variety. The ornamentation of the figured specimens suggests *Bolivina* rather than *Siphogenerina.*

### SIPHOGENERINA IRREGULARIS (Bagg)

Plate 1, figs. 11, 12

*Sagrina irregularis* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 152, pl. 5, figs. 8–10.

*Siphogenerina irregularis* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 109, pl. 47, figs. 6, 7.

*Description.*—Test elongate, subcylindrical; chambers somewhat irregular, but becoming uniserial in the last-formed portion; sutures distinct, depressed; wall thin, translucent, surface with numerous, slightly raised, longitudinal costae; apertural end of the chamber depressed, the aperture with a long slender cylindrical neck and slightly flaring lip.

Length, 0.75–1.50 mm.

*Distribution.*—Nothing is known of this species outside the region of the Hawaiian Islands. Bagg originally described it from *Albatross* collections off the Hawaiian Islands in 275–384 fathoms. I later had it from *Albatross* and *Nero* stations in the same region, in 268–392 fathoms.

The distinguishing characters of the species are the thin wall, numerous longitudinal costae, and especially the peculiar way in which the apertural neck is set down into a depression of the last-formed chamber.

Young specimens which have not yet developed the uniserial character very strongly resemble *Uvigerina nitidula* Schwager.[11] I have recorded it from the Lower Oligocene (Prof. Pap. 133, U. S. Geol. Surv., 1923, p. 35) but these specimens probably belong elsewhere.

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[10] Trans. Zool. Soc. London, vol. 20, 1915, p. 677.

[11] *Novara*-Exped., Geol. Theil., vol. 2, 1867, pl. 7, fig. 93.

### SIPHOGENERINA STRIATULA Cushman

Plate 1, fig. 10*a*, *b*

*Siphogenerina striatula* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 108, pl. 47, fig. 1.—YABE and HANZAWA, Jap. Journ. Geol. Geog., vol. 2, No. 2, 1923, p. 32.

*Description.*—Test elongate, subcylindrical; chambers mostly broader than long, the last-formed one nearly as long as broad; sutures distinct, slightly depressed; surface ornamented with very fine, longitudinal striae; aperture narrowly elongated, without a definite neck but with a well-developed lip.

Length about 1 mm.

*Distribution.*—I originally found this species in material from numerous stations between Yokohama and Japan, at depths ranging from 859 to 1,660 fathoms. Yabe and Hanzawa record it as rare from the Pliocene shell beds of Nojima, Japan.

It would seem, therefore, that it is a species of the northwestern Pacific. The finely striate surface and elongate aperture are characteristic.

### SIPHOGENERINA LAMELLATA Cushman

Plate 1, fig. 13

*Siphogenerina lamellata* CUSHMAN, Bull. 676, U. S. Geol. Surv., 1918, p. 55, pl. 12, fig. 3.

*Description.*—Test elongate, tapering gradually from the initial end, broadly rounded at the apertural end; chambers comparatively few, indistinct, surface ornamentations consisting of several equidistant, longitudinal lamellae extending from the initial end to the apertural end, where they fuse; aperture with a tubular neck and phialine lip.

Length 1 mm.

This species is known only from the Miocene of Florida, from the Choctawhatchee Marl, one mile south of Red Bay, Florida. Its nearest relative is *S. spinosa* Bagg from the Miocene of Maryland, but the Florida species has much stronger developed lamellae and no evidence of a spinose base.

### SIPHOGENERINA SPINOSA (Bagg)

Plate 1, fig. 14

*Sagrina spinosa* BAGG, Maryland Geol. Surv. (Miocene), 1904, p. 480, pl. 133, fig. 11.

*Siphogenerina spinosa* CUSHMAN, Bull. 676, U. S. Geol. Surv., 1918, p. 55.

*Description.*—The original description of this species is as follows:

> This peculiar and interesting species somewhat resembles *S. raphanus* Parker and Jones, but differs from the latter in several particulars. The surface ridges in our specimen end in a series of projecting points which at the distal end become definite spines, though these are short and stubby. Again there are arched

ridges between these costae which, while they may not indicate the internal structure of the chambers, serve to mark their location. The aperture ends in a neatly raised, phialine, everted lip with central rounded orifice.

Length about 1 mm.

The type specimen is from the Miocene, Choptank Formation, Jones Wharf, Maryland. I have had this specimen for study, and the sutures seem much more clearly marked than in the figure. It is a microspheric specimen.

It is related to *S. lamellata* Cushman, which is a more extremely lamellate species.

### SIPHOGENERINA COLUMELLARIS (H. B. Brady)

Plate 2, figs. 4, 11; plate 3, figs. 1–4; plate 4, figs. 5, 6; plate 5, figs. 9–11

*Sagrina columellaris* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 581 pl. 75, figs. 15–17.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 36.—FORNASINI, Rend. Accad. Sci. Bologna, vol. 1, (1896–97) 1897, p. 55, text figure; Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 8, 1900, p. 391, fig. 41.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 28, 1902, p. 404.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 270, pl. 5, figs. 10, 11.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 151.—HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 676.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 148, pl. 5, fig. 24.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 185; Journ. Linn. Soc. Zool., vol. 35, 1924, p. 626.

*Siphogenerina (Sagrina) columellaris* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 316, pl. 9, figs. 28, 31, 33.

*Siphogenerina columellaris* SILVESTRI, Atti Pont. Accad. Nuovi Lincei, ann. 55, 1902, p. 1, figs. 1, 2.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 104, pl. 47, figs. 2, 3; Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 276, pl. 56, fig. 1; Publ. 342, Carnegie Inst. Washington, 1924, p. 29, pl. 8, figs. 5, 6.

*Siphogenerina glabra* SCHLUMBERGER, Feuille des Jeunes Naturalistes, 1883, p. 118, pl. 3, fig. 1.

*Description.*—Test elongate, subcylindrical, somewhat tapering, straight or very slightly curved; chambers comparatively few, those of the uniserial portion well rounded, shorter than broad; sutures only slightly constricted; aperture large, terminal, with a very short tubular neck and broad flaring lip; wall smooth.

Length about 1 mm.

*Distribution.*—Brady's Challenger records for this species are as follows: "Off Gomera and off Palma, Canaries, at 600 fathoms and 1,125 fathoms, respectively; off the Azores, 450 fathoms; off Pernambuco, 350 fathoms; on the shore at Tamatave, Madagascar; at three stations on the southeast coast of Australia, 6 fathoms to 410 fathoms; and at five amongst the islands of the South Pacific, 125 to 620 fathoms." Chapman records it from the Arabian Sea and off Funafuti; Millett from the Malay Archipelago; Bagg from the region of the Hawaiian Islands; Sidebottom from the east coast of Australia, and Heron-Allen and Earland, the Kerimba Archipelago, from Lord Howe Island, and from the Antarctic Expedition. Egger's specimens were from off western Australia and Mauritius.

I have recorded the species from numerous stations in the North Pacific from Hawaii to Japan; in the Philippine region, and from Samoa.

Unless more than one species is involved, this is much more widely distributed than other species of the genus.

Egger records it from the Cretaceous of central Europe, but his figure in end view certainly does not have the apertural characters of *S. columellaris.*

### SIPHOGENERINA COLUMELLARIS (H. B. Brady), var. NODOSAROIDES Schubert

*Sagrina raphanus* PARKER and JONES, var. *nodosaroides* SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 88, text figures 8, 9*a*, *b*.

Under the above name Schubert figures a very long, slender form, with smooth surface and 14 chambers in the uniserial portion. There is no neck or lip, and the entire appearance is that of *S. columellaris* rather than *raphanus*, and it apparently should be placed as a variety of the former. It is more slender than the typical, and has a few more chambers. The type of the variety was from coral sand of Maria Island in the Paumotu Group.

### SIPHOGENERINA COLUMELLARIS (H. B. Brady), var. SEMISTRIATA Schubert

*Sagrina raphanus* PARKER and JONES, var. *semistriata* SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 89, text figures 10*a*, *b*.

Schubert describes and figures a form which has the latter half of the test smooth, the earlier portion with numerous slight costae. The general form of the test and the apertural characters very strongly suggest *S. columellaris.* His specimen was from the Pteropod clays of Sainabas in the Bismarck Archipelago, late Tertiary in age.

### SIPHOGENERINA HUGHESI Cushman

*Siphogenerina hughesi* CUSHMAN, Cushman Lab. Foram. Res., vol. 1, pt. 2, 1925, p. 36, pl. 7, figs. 4*a*, *b*.

Test elongate, fairly thick, two or three times as long as broad, circular in transverse section; chambers short and broad, the early chambers irregularly spiral, later ones uniserial; sutures distinct and depressed; wall thick, the exterior smooth throughout; aperture terminal, rounded, with a short neck and slight lip.

Length 1 mm. or slightly more; breadth 0.50 mm.

Holotype (Cushman Coll. No. 4364) from the Miocene Monterey shales near Chimney Rock, San Luis Obispo County, California.

The species is named for Donald D. Hughes, paleontologist of California.

### SIPHOGENERINA DIMORPHA (Parker and Jones)

Plate 3, fig. 5

*Uvigerina* (*Sagrina*) *dimorpha* PARKER and JONES, Philos. Trans., vol. 55, 1865, p. 420, pl. 18, fig. 18.

*Sagrina dimorpha* H. B. BRADY, Journ. Roy. Micr. Soc., 1887, p. 915.—H. B. BRADY, PARKER and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 225, pl. 45, fig. 6.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 52, pl. 9, figs. 510, 511.—KIAER, Rep't. Norwegian Fish. and Mar. Invest., vol. 1, No. 7, 1900, p. 37.—HERON-ALLEN and EARLAND, Trans. Linn. Soc. London, ser. 2, vol. 2, 1916, p. 266.

*Siphogenerina dimorpha* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 175, pl. 42, figs. 16–18.

*Description.*—Test somewhat compressed, very slightly tapering, the greatest width usually near the apertural end; chambers comparatively few, rather broader than high, slightly inflated; sutures distinct, the basal portion in the last-formed chambers sometimes slightly excavated tending to bridge the sutures between the excavations at regular intervals; wall with a coarsely pitted surface; aperture circular, terminal, at the end of a short neck, usually with a distinctly phialine lip.

Length not over 0.60 mm.

*Distribution.*—This species should be distinguished from the following variety. Parker and Jones figured as their type a specimen from the Abrohlos Bank off Brazil. It must, therefore, be taken as the type, and the Pacific form made a variety.

Atlantic records include the Abrohlos Bank (Parker and Jones: H. B. Brady, Parker and Jones); Bukken and Oster Fiords, near Bergen, Norway (Norman) (Brady) (Goës) (Kiaer); Vest Fiord (Kiaer); low water, Howport, Girvan, Scotland (Robertson) (Brady); west of Scotland, rare (Heron-Allen and Earland); off Gomera, Canaries, and off Culebra Island, West Indies (Brady), and possibly in the South Atlantic, off Ascension Island (Brady).

I have had specimens from off the coast of Georgia, between Cuba and Yucatan, and from three stations in the Caribbean.

It has, therefore, a rather wide Atlantic distribution.

The Pacific form is the following variety:

### SIPHOGENERINA DIMORPHA (Parker and Jones), var. PACIFICA, new variety

Plate 2, fig. 9; plate 3, figs. 6*a*, *b*

*Uvigerina* (*Sagrina*) *dimorpha* PARKER and JONES (part), Philos. Trans., vol. 155, 1865, p. 420.

*Sagrina dimorpha* H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 582, pl. 76, figs. 1–3.—BAGG, Bull. 34, U. S. Nat. Mus., 1908, p. 152.—SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 86.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 148.—HERON-ALLEN and EARLAND, British Antarctic "*Terra Nova*," Exped., Zoology, vol. 6, 1922, p. 186.

*Siphogenerina dimorpha* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 317, pl. 9, fig. 30.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 106, pl. 45, figs. 3, 4; Bull. 100, pt. 4, 1921, p. 279, pl. 56, fig. 8.

*Description.*—Variety differing from the typical in the greater number of uniserial chambers, the cylindrical form of the test, and the much more prominent depressions at the base of the chambers along the sutures.

*Distribution.*—This variety is widely distributed in the Pacific. Parker and Jones had it from the Red Sea (near the Isle of Shadwan) and Australian coral reefs. Brady had it from off Tahiti, the Ki Islands, and off Kandavu, Fiji. It has occurred off the Hawaiian Islands (Bagg, Cushman), and I have had it from several stations in the western Pacific off Japan and the Bonin Islands, as well as a few stations in the Philippines. Sidebottom records it off the eastern coast of Australia, and Heron-Allen and Earland from several stations off New Zealand. Egger's only station is in the western part of the Indian Ocean.

The only fossil records for this area is that of Schubert, who recorded it in a *Globigerina* marl of late Tertiary age from Panaras in the Bismarck Archipelago and Koch, who records it from the late Tertiary of Kabu, Java.

It may be noted here that Halkyard records this species as occurring in the Blue Eocene Marl of Biarritz.[12] Heron-Allen and Earland note: "The specimens are longer, thinner in the shell wall, and the cusps between the chambers are much less pronounced than in recent types, but in other features they agree tolerably well with *Sagrina dimorpha* Parker and Jones." It would seem, then, as though these Eocene specimens may represent a varietal form more closely allied to the typical Atlantic form than to the Pacific variety.

### SIPHOGENERINA VIRGULA (H. B. Brady)

Plate 2, figs. 7, 8; plate 4, figs. 8, 9

*Sagrina virgula* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 275, pl. 8, figs. 19–21; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 583, pl. 76, figs. 4–7 (not 8–10).—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 271.—HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 676, pl. 51, figs. 4, 5.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 148.—HERON-ALLEN and EARLAND, British Antarctic (*Terra Nova*) Exped., Zoology, vol. 6, 1922, p. 186.

*Siphogenerina (Sagrina) virgula* EGGER, Abh. kön. Bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 318, pl. 9, fig. 27.

*Siphogenerina virgula* CUSHMAN, Publ. 342, Carnegie Inst. Washington, 1924, p. 29, pl. 8, figs. 3, 4.

*Description.*—Test elongate, somewhat tapering, composed of a number of inflated chambers, the early ones in a uvigerine arrangement, later ones uniserial, the uniserial portion making up most of the test, surface hispid; aperture large, terminal, with a broad everted lip, the border of which often has a series of backwardly pointing, long, acicular spines.

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[12] Mem. Proc. Manchester Lit. Philos. Soc., vol. 62, 1919, p. 39.

Length up to 1 mm.

*Distribution.*—Except for one record by Brady from the South Atlantic, all other records are from the Indo-Pacific. Brady records it from several South Pacific stations in 12 to 2,075 fathoms. Millett notes it as common in his Malay Archipelago material, and Sidebottom from off the east coast of Australia. Heron-Allen and Earland record it from the Kerimba Archipelago off southeastern Africa and from the Antarctic expedition collections. Egger records it from off western South Africa and off western Australia. I have had abundant material from 50 fathoms at Samoa. Its Indo-Pacific distribution, even though wide, does not include the Philippines nor the islands in the Pacific north of the equator.

It is very distinct from other species of the genus in the development of spines from the edge of the lip.

### SIPHOGENERINA MEXICANA, new species

Plate 5, figs. 4*a*, *b*

*Description.*—Test small, elongate, slender, the early portion triserial, tapering from a subacute initial end, the later portion cylindrical, composed of several chambers—up to eight—in a straight line; chambers distinct, those of the later portion inflated; sutures distinct, depressed, especially toward the apertural end; wall with numerous, rather course punctae, which are almost entirely confined to the basal half of each chamber, wall toward the early portion of the test with short, longitudinal costae, the later portion of the test smooth, thin, translucent; the apertural end truncate with a broad elliptical aperture connecting with the previous aperture by an internal tubular neck.

Length up to 1 mm.

*Type specimens.*—(Cat. No. 353174 U. S. N. M.) from Rio Buena Vista, 0.5 kms., 25°E. from Tumbadero Hacienda House, Vera Cruz, Mexico, T. Wayland Vaughan collector. Specimens also are in the United States National Museum collections from other localities in the Alazan clays in the same general region. The species also occurs in the Eocene of the Coastal Plain of the United States.

This species is undoubtedly the ancestor of *S. advena* Cushman, now living in the Gulf of Mexico, the Caribbean Sea, and adjacent regions of the western Atlantic. The living species has taken on a compressed character of the test; the ornamentation of the basal portion is somewhat different, having assumed a spinose condition, but the general characters of the two are very much alike. Both have the basal portion of the uniserial chambers punctate and the distal portion clear, although the relative amount of each is different in the two species.

### SIPHOGENERINA ADVENA Cushman

Plate 5, figs. 3*a*, *b*

*Siphogenerina advena* CUSHMAN, Publ. 311, Carnegie Inst. Washington, 1922, p. 35, pl. 5, fig. 2; Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 173, pl. 42, fig. 15.

*Description.*—Test elongate, somewhat compressed, early portion either triserial or biserial, later portion, which makes up the larger portion of the test, uniserial; chambers numerous, distinct, inflated; sutures somewhat depressed, the early portion and a part of the uniserial portion with fine, longitudinal costae, more or less broken, followed by two or three chambers slightly spinose, after which the remaining chambers are smooth and very finely punctate; aperture elliptical, each one connecting with the preceding by an internal funnel-shaped tube.

Length up to 0.65 mm.

*Distribution.*—This species was originally described from the Tortugas region of southern Florida in comparatively shallow water. It has also occurred in the western part of the Caribbean off Central America in 382 fathoms, and off the Carolina coast in 168 fathoms. It seems therefore to be a species of the tropical western Atlantic.

A small species was figured by Goes as "*Textularia Pennatula,* var. *aculeata* forma Bigenerina",[13] and he afterwards gave it a new name, *Sagrina pygmaea.*[14] The specimen was from 300 fathoms in the Caribbean Sea. It may possibly be the same as our species, but the figure does not show any surface ornamentation, and his description is inadequate. I have not found his type specimen.

### SIPHOGENERINA BIFRONS (H. B. Brady)

Plate 3, figs. 7–9; plate 4, fig. 4

*Sagrina bifrons* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 64; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 582, pl. 75, figs. 18–20.—MILLETT Journ. Roy. Micr. Soc., 1903, p. 270.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 415.—SCHUBERT, Abhandl. geol. Reichs., vol. 20, pt. 4, 1911, p. 86.—HERON-ALLEN and EARLAND, British Antartic Exped., Zoology, vol. 6, 1922, p. 186.

*Siphogenerina* (*Sagrina*) *bifrons* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 317, pl. 9, figs. 25, 26, 29.

*Siphogenerina bifrons* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 105, pl. 45, figs. 1, 2, 5–7; Bull. 100, vol. 4, 1921, p. 277, pl. 56, figs. 2, 3.

*Description.*—Test elongate, compressed, straight or very slightly curved, in end view elliptical, median portions of the broad faces somewhat concave, megalospheric form with the initial end broadly rounded and of about the same diameter as the rest of the test, microspheric form with the initial end much more attenuate, growing rapidly broader, then contracted where the uniserial portion begins; sutures hardly depressed, distinct, often of clear material, appearing darker than the rest of the test; aperture rounded or elliptical, without a distinct neck but with a slight rounded lip; microspheric form usually the larger.

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[13] Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 79, pl. 5, figs. 165, 166.

[14] Bull. Mus. Comp. Zool., vol. 29, 1896, p. 51.

Length, 0.75–1 mm.

*Distribution.*—The species was originally described by Brady from a dredging of the *Challenger* in 345 fathoms on the *Hyalonema* ground off southeastern Japan, and was apparently not obtained elsewhere by the *Challenger*. Egger records it from off western Australia but his figures are not at all characteristic, and may not represent the species. Millett's note on his Malay collections is as follows: "Of this rare form a few poor examples occur at several stations." He does not figure them. Chapman records a specimen from off Funafuti in 2,400 fathoms. I had excellent material from stations off southern Japan and the Philippines.

In the fossil state it is recorded by Schubert from the Bismarck Archipelago, and by Heron-Allen from the Antartic. Egger records it from the Cretaceous of Central Europe, but an examination of the figures he gives shows little in common with the Pacific material, and the Cretaceous material is something else.

The very restricted records for this species seem to show that its main range is from southern Japan to the Philippines, and southward. Most of the records are in considerable depths, and it does not belong to the ordinary "coral-reef fauna," but probably is more widely distributed in the Indo-Pacific than the few records indicate.

### SIPHOGENERINA BIFRONS (H. B. Brady), var. SYDNEYENSIS (Goddard and Jensen)

Plate 3, figs. 10*a*, *b*

*Sagrina sydneyensis* GODDARD and JENSEN, Proc. Linn. Soc. New South Wales, vol. 32, 1907, p. 304, pl. 6, figs. 4*a*, *b*.

The description given by the authors is as follows:

> This species has a straight cylindrical test. The commencement is a large hemispherical chamber, which, however, contains one septum, indicating a uvigerine commencement. The subsequent chambers are short and cylindrical, and do not at first increase in diameter. Subsequently they increase slowly in diameter as well as in length (fig. 4*a*; pl. 3, fig. 10*a*). The surface of each chamber is ornamented with minute spines, and two or three extraordinarily large oval pores. The latter are irregularly distributed, but are chiefly found toward the proximal end of each segment. Size: Length, 0.57 mm.

From the figure given by the authors this seems very certainly a varietal form of *S. bifrons* (H. B. Brady).

The specimens were from 300 fathoms, 27.5 miles east of Sydney Heads, New South Wales, dredged by C. Hedley.

### SIPHOGENERINA BIFRONS (H. B. Brady), var. STRIATULA Cushman

Plate 2, fig. 6; plate 4, figs. 1–3

*Siphogenerina bifrons* (H. B. Brady), var. *striatula* Cushman, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 662; vol. 56, 1919, p. 620; Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 278, pl. 56, fig. 4.

*Description.*—Variety differing from the typical in having the surface with numerous longitudinal striations, rather more elongate, and the central indented portion deeper and more defined.

The only localities for this variety are in the Pacific. It was originally described from the Philippines, where it occurs at numerous stations in 135 to 554 fathoms with a single record at 1,262 fathoms. I have also had it from off New Zealand.

Heron-Allen and Earland[15] mention feebly striate specimens of *S. bifrons* occurring as fossils.

### SIPHOGENERINA AUSTRALIENSIS (Goddard and Jensen)

*Sagrina australiensis* Goddard and Jensen, Proc. Linn. Soc. New South Wales, vol. 32, 1907, p. 299, pl. 6, figs. 3*a–c*.

The authors describe this species as follows:

> This species has a uvigerine commencement, after which it consists of a uniserial row of oval chambers cylindrical in section. The character of the shell is intermediate between *S. dimorpha* and *S. virgula.* The shell is thick and studded with large pits as in *S. dimorpha.* There are also tubercles externally approximating to the spines of *S. virgula.* The neck is as in *S. virgula.*
>
> There is a distinct constriction at the junction of the chambers, and some of the chambers are prodeced outwards into small monticular prominences. (See fig. 3*a*.) The chambers increase gradually in size.
>
> Under a high power the surface appears as in fig. 3*b*. On focussing down, canals are seen in the walls, extending from the interior and opening to the exterior in the small tubercles.

Size: Length, 0.7 mm.

Their specimens were from 15 fathoms, off Palm Island, near Townsville, Queensland, collected by C. Hedley.

From the rather poor figures and rather meagre description, it is difficult to discover much as to the relationships of this form.

There is a very slender species with numerous uniserial chambers and 10 to 12 costae, which occurs in the Navarro, Upper Cretaceous clays, one-half mile south of Kemp, Texas. This may be known as *Siphogenerina plummeri* Cushman, new species, and will be figured later.

There are numerous other species assigned by various authors to *Sagrina* which do not seem properly to belong to *Siphogenerina.*

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[15] British Antarctic Exped., Zoology, vol. 6, 1922, p. 186.

## GENUS PAVONINA d'ORBIGNY

The genus *Pavonina* was originally described by d'Orbigny in 1826 [16] in a few words: "Plusiers ouvertures aux loges; test deprimé latéralement; loges concentriques." The type species *Pavonina flabelliformis* is given from Madagascar. There is no specific description, but a figure is given, and the species is illustrated also in the Modèles, No. 56. The early chambers of the Modèle show definitely alternating chambers in the ones I have seen, but neither the 1826 figure nor its modification in 1846 [17] show this character. Neither does the more elaborated description of 1846 make any mention of the textularian character of the early chambers. This lack of alternating chambers in the figures given by d'Orbigny so deceived Parker and Jones that in their review of d'Orbigny's 1826 work [18] they conceive the idea that it may belong to the Miliolidae and be a form of either *Peneroplis* or *Orbitolites*. It was therefore not until Brady obtained good material first from the Seychelles [19] and later from the *Challenger* Expedition,[20] that the true structure of this species and of the genus became known. Brady correctly placed *Pavonina* in the Textulariidae. Moebius in 1880 [21] described and figured specimens from Mauritius, and still further calls attention to the true structure. Since the excellent figures given by Brady also in the *Challenger* Report [22] little further needs to be added to this particular species, but since that date other species have been distinguished. These will be noted later.

### Genus PAVONINA d'Orbigny, 1826

*Pavonina* D'ORBIGNY (type, *P. flabelliformis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 260; Foram. Foss. Bass. Tert. Vienne, 1846, p. 72.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 274.—CHAPMAN, The Foraminifera, 1902, p. 169.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 30; Bull. 104, pt. 3, 1922, p. 51.

*Description.*—Test calcareous, hyaline, perforate, many-chambered, the early chambers biserial, alternating, the later ones uniserial, broad, curved, in the type species becoming embracing, this later series finally composed of one or more chambers; sutures limbate; wall usually thin and translucent, coarsely perforate; apertural wall with one or more rows of rounded apertural openings.

The genus is known both in the Tertiary and in the present ocean, represented by several species.

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[16] Ann. Sci. Nat., vol. 7, 1826, p. 260.

[17] Foram. Foss. Vienne, 1846, pl. 21, figs. 9 and 10.

[18] Ann. Mag. Nat. Hist., vol. 12, 1863, p. 440.

[19] Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 41.

[20] Quart. Journ. Micr. Sci., vol. 19, 1879, p. 68, pl. 8, figs. 29, 30.

[21] Beitr. Meeresfauna Insel Mauritius, 1880, p. 91, pl. 8, figs. 13-15

[22] P. 374, pl. 45, figs. 17-21.

### PAVONINA FLABELLIFORMIS d'Orbigny

Plate 6, figs. 1–4

*Pavonina flabelliformis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 260, pl. 10, figs. 10, 11; For. Foss. Vienne, 1846, p. 72, pl. 21, figs. 9, 10.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 27, pl. 1, fig. 22.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 282, pl. 8, figs. 29, 30.—MÖBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 91, pl. 8, figs. 13–15.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 374, pl. 45, figs. 17, 19–22 (not 18).—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 7.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 30, figs. 51, 52 (in text).—HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 632, pl. 48, figs. 1–6; Journ. Linn. Soc. Zool., vol. 35, 1924, p. 619; Journ. Roy. Micr. Soc., 1924, p. 141, pl. 8, fig. 22.

*Pavonina flabelloides* BRONN, Klassen und Ordnungen Thier-Reichs, vol. 1, 1859, p. 72, pl. 6, figs. 13*a*, *b*.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 204, pl. 18, fig. 13.

*Description.*—Test free, many-chambered, much compressed, the early portion consisting of a few small chambers arranged biserially, the later chambers curved, spreading, uniserial or divided into more than one in each curve, in adults often with the chambers becoming almost annular; sutures somewhat limbate, depressed, distinct; wall thin and transparent, coarsely and irregularly punctate, the wall about these punctae often thickened and slightly raised; apertures in one or more linear rows about the periphery of the test, the peripheral face concave; color white.

The diameter of the test rarely exceeds 1 mm.

The species has an interesting distribution. The early specimens of d'Orbigny were from Madagascar. It is apparently most abundant in that general region as Heron-Allen and Earland record it very splendidly developed in the Kerimba Archipelago nearby. Brady's records of this species are "Madagascar, shore sand; Seychelle Islands, shallow water; Port Louis, Mauritius, harbor mud; off Calpentyn, Ceylon, 2 fathoms; off Raine Island, Torres Strait, 155 fathoms; Nares Harbor, Admiralty Islands, 17 fathoms; and Honolulu Reefs, 40 fathoms." He records it also from Millet's collection from the coast of Korea. Moebius had material from Mauritius. Millett records a solitary specimen from his Malay Archipelago collections. Bagg had it from *Albatross* station D 4174, off the Hawaiian Islands, and I have had it from Nero station 2042 in 55 fathoms, also off Honolulu, Nero station 201, in 1,033 fathoms near Midway Island, and station 1310 in 518 fathoms, near the Bonin Islands. There is a single specimen in *Tanager* collections from 31 fathoms off Dowsett Reef, to the northwestward of the Hawaiian Islands. Heron-Allen and Earland record it from Lord Howe Island in the South Pacific.

Specimens are recorded from the Miocene (Filter Quarries) of Victoria by Heron-Allen and Earland.[23] I have had specimens from the same locality, but none of them show the embracing chambers of typical recent specimens, and the surface ornamentation seems different. Howchin[24] records the species from the Eocene of Muddy Creek, Victoria, but does not figure it.

The figures of this species given by Heron-Allen and Earland from the Kerimba region show very beautiful tests. The largest of their specimens figured is slightly more than a millimeter in diameter.

*Pavonina flabelliformis* is replaced in the Atlantic by the following species:

### PAVONINA ATLANTICA Cushman

Plate 6, figs. 5, 6

*Pavonina flabelliformis* H. B. BRADY (in part) (not d'Orbigny), Rep. Voy. *Challenger*, vol. 9, 1884, p. 374, pl. 45, fig. 18 (not 17, 19–21).—WOODWARD, The Observer, vol. 4, 1893, p. 104.

*Pavonina atlantica* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 51, pl. 19, fig. 1.

*Description.*—Test subtriangular, slightly longer than broad, initial end with a short spine, very much compressed, the sides carinate; chambers comparatively few, the earliest ones alternating, biserial, those of the adult uniserial, broad, and low, extending across the width of the test, slightly curved backwards at the ends; sutures somewhat limbate, wall thin and transluscent, finely perforate; apertures numerous on the terminal wall of the last-formed chamber.

Length up to 0.5 mm.

The type specimen of this species is from off Sand Key, Florida, in 92 fathoms. It was also found at stations off Florida and in the Tortugas lagoon. The specimens recorded by Brady as *P. flabelliformis* from off Culebra Island in 390 fathoms are this species. Plate 45, Figure 18, of the *Challenger* Report is from this station. Figures 19 and 20 are *P. flabelliformis* from shore sand of Tamatave, Madagascar, and Figure 21 is from off Calpentyn, Ceylon in 2 fathoms. I have no data for Figure 17, but it is probably from Madagascar.

Brady's figure (pl. 45, fig. 18), shows the traces of the lateral carinae characteristic of *P. atlantica.*

*Pavonina atlantica* in its very triangular form throughout instead of the circular form of *P. flabelliformis* is very distinctive. In this character *P. atlantica* is nearer to the following species:

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[23] Journ. Roy. Micr. Soc., 1924, p. 141, pl. 8, fig. 22.

[24] Trans. Proc. Roy. Soc. So. Australia, vol. 12, 1889, p. 7.

### PAVONINA MEXICANA new species

Plate 6, figs. 7–9

*Description.*—Test large, about as long as broad, roughly triangular, gradually tapering to the somewhat truncate base, much compressed; chambers numerous, the earlier ones biserial, the later ones very elongate, uniserial, apertural end rounded, sutures slightly limbate, sometimes beaded; wall slightly arenaceous, but smoothly finished; apertures about the peripheral face.

Length up to 1.25 mm.

*Type specimens.*—(Cat. No. 353173 U.S.N.M.) from the Tertiary of Mexico. This is in the Alazan Clay of Rio Buena Vista, 0.5 kms. 25° E. from Tumbadero Hacienda House, state of Vera Cruz, T. W. Vaughan, collector.

This is the only known locality for this species but it was in some numbers at this place. In the early development there is a spiral arrangement of the chambers before the alternating character is taken on showing the relation of *Spiroplecta* and *Textularia*, as in other genera of the Textulariidae. This coiling brings the proloculum and early chambers some distance in from the periphery. Often the proloculum is large, apparently megalospheric, and is thicker than the rest of the test, giving an umbonate appearance to the early portion.

This Tertiary species is apparently the largest of the genus.

### PAVONINA ADVENA Cushman

*Pavonina advena* CUSHMAN, U. S. Geol. Survey Prof. Paper 133, 1923, p. 24, pl. 1, fig. 10.

Test of comparatively few chambers, only the very early ones showing a trace of the biserial arrangement; succeeding chambers rapidly increasing in width until an annular chamber is developed; wall thin, translucent, finely punctate, otherwise smooth.

Diameter slightly less than 0.50 mm.

This somewhat resembles *P. flabelliformis*, which is characteristic of certain parts of the Indo-Pacific region in shallow water but which has much coarser pores. It is less closely like *P. atlantica*, which I have described from material obtained off the Florida coast.

The types were from U. S. G. S. station 7376, from Byram marl, Lower Oligocene, Leaf River, Miss.

There are two other species described from the Tertiary of Europe, *Pavonina agglutinans* Schubert and *P. liburnica* Stache, but I have been unable to obtain specimens of these.

*Pavonina liburnica* Stache[25] does not from the figures seem to be a species of this genus, and it is difficult to place it without seeing type material.

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[25] Abhandl.k.k. geol. Reichs., vol. 13, 1889, p. 89, pl. 5*a*, figs. 1–19.

## EXPLANATION OF PLATES

### PLATE 1

FIGS. 1, 2. *Siphogenerina raphanus.* Original figures. ×30. Specimens from "East Indian Seas."

3, 4. *Siphogenerina raphanus.* ×40. Specimens from the North Pacific. Figure 3, megalospheric; figure 4*a* microspheric; 4*b*, end view.

5. *Siphogenerina raphanus*, var. *tropica.* ×66. Microspheric specimen.

6. *Siphogenerina raphanus*, var. *transversus.* ×35.

7–9. *Siphogenerina branneri.* (After Bagg.) ×23. From the Miocene-Monterey shale of California. Figure 7, microspheric form, type specimen; figures 8, 9, megalospheric forms. Figure 8, *Sagrina californiensis;* figure 9, *Sagrina elongata.*

10*a*, *b*. *Siphogenerina striatula.* ×75. *a*, front view; *b*, apertural view. From the North Pacific.

11, 12. *Siphogenerina irregularis.* ×75. Figure 11*a*, front view; *b*, apertural view; figure 12, median section of last two chambers. From off the Hawaiian Islands.

13. *Siphogenerina lamellata.* ×60. Miocene, one mile south of Red Bay, Florida.

14. *Siphogenerina spinosa.* (After Bagg.) ×40. From the Miocene, Jones Wharf, Maryland.

### PLATE 2

FIGS. 1, 2. *Siphogenerina raphanus.* ×65. Figure 1, microspheric; figure 2, megalospheric. Specimens from Samoa.

3. *Siphogenerina raphanus.* ×50. Megalospheric specimen from Tortugas region, Gulf of Mexico.

4. *Siphogenerina columellaris.* ×65. Specimen from the Philippines.

5. *Siphogenerina striata*, var. *curta.* ×65. Specimen from the Philippines.

6. *Siphogenerina bifrons*, var. *striatula.* ×65. Specimen from the Philippines.

7, 8. *Siphogenerina virgula.* ×65. Specimens from Samoa.

9. *Siphogenerina dimorpha*, var. *pacifica.* ×65. Specimen from the Philippines.

10. *Siphogenerina raphanus.* ×75. Later chambers by transmitted light, showing central tubes.

11. *Siphogenerina columellaris.* ×65. Microspheric specimen from Samoa.

### PLATE 3

FIGS. 1, 2. *Siphogenerina columellaris.* ×100. Sections. (After Silvestri.) Figure 1, megalospheric; figure 2, microspheric form.

3. *Siphogenerina columellaris.* ×75. Specimen by transmitted light.

4*a*, *b*. *Siphogenerina columellaris.* ×75. *a*, front view; *b*, apertural view Specimens from the North Pacific.

5. *Siphogenerina dimorpha.* ×30. Figure of type specimen. (After Parker and Jones.) From the Abrohlos Bank, Atlantic.

6*a*, *b*. *Siphogenerina dimorpha*, var. *pacifica.* ×65. *a*, front view; *b*, apertural view. Specimen from the North Pacific.

7, 8. *Siphogenerina bifrons.* ×70. Figure 7, megalospheric, figure 8*a*, microspheric form, figure 8*b*, apertural view. Specimens from off Japan.

9. *Siphogenerina bifrons.* ×65. Specimen from the Philippines.

10*a*, *b*. *Siphogenerina bifrons*, var. *sydneyensis.* (After Goddard and Jensen.) *a*. ×90; *b*, showing pores and structure of wall.

## PLATE 4

FIGS. 1–3. *Siphogenerina bifrons*, var. *striatula*. ×75. Specimen from the Philippines.

4. *Siphogenerina bifrons*. ×75. Broken, microspheric specimen. From off Japan.

5, 6. *Siphogenerina columellaris*. (After Millett.) ×100. Figure 5, microspheric specimen, showing the internal structure; figure 6, megalospheric form. Specimens from the Malay Archipelago.

7. *Siphogenerina branneri*. ×75. Specimen from the type locality.

8, 9. *Siphogenerina virgula*. (After Heron-Allen and Earland.) ×100. Specimens from the Kerimba Archipelago, Southeast Africa.

## PLATE 5

FIGS. 1, 2. *Siphogenerina raphanus*. ×75. Specimens from Porto Rico.

3*a*, *b*. *Siphogenerina advena*. ×75. *a*, front view; *b*, apertural view. Specimens from Tortugas region, Gulf of Mexico.

4*a*, *b*. *Siphogenerina mexicana*. ×75. *a*, front view; *b*, side view. Specimens from the Upper Eocene, Alazan Clay, Mexico.

5, 6. *Siphogenerina striata*, var. *curta*. ×75. Specimens from the Philippines.

7, 8. *Siphogenerina raphanus*, var. *tropica*. ×75. Specimens from the Philippines.

9–11. *Siphogenerina columellaris*. ×75. Figures 9, 10, megalospheric forms from the Philippines; figure 11, microspheric form from Samoa.

## PLATE 6

FIGS. 1–4. *Pavonina flabelliformis*. (After Heron-Allen and Earland.)

1. Young with the textularian stage just completed. ×50.
2. Early stage showing the semicircular chambers already developed. ×50.
3. Adult specimen with the chambers nearly annular. ×50.
4. Side view of specimen mounted in balsam, showing the arrangement of chambers in the development of the test. ×70. (Specimens from the Kerimba Archipelago.)

FIGS. 5, 6. *Pavonina atlantica*.

Young specimens from the coast of Florida, showing the textularian young, and the wedge-shaped test instead of the broadly curved chambers of the preceding species. The ornamentation of the biserial portion is much coarser than that of the later uniserial chambers. ×100.

FIGS. 7–9. *Pavonina mexicana*, new species.

7. Somewhat broken specimen, showing the trucate initial end, the proloculum and spiral chambers followed by a number of textularian chambers. The uniserial chambers show no tendency to become nearly annular. ×50.
8. A young specimen, showing the details of the early chambers. ×100.
9. A partially developed specimen. ×50. (Specimens from the Alazan Clays of Mexico.)

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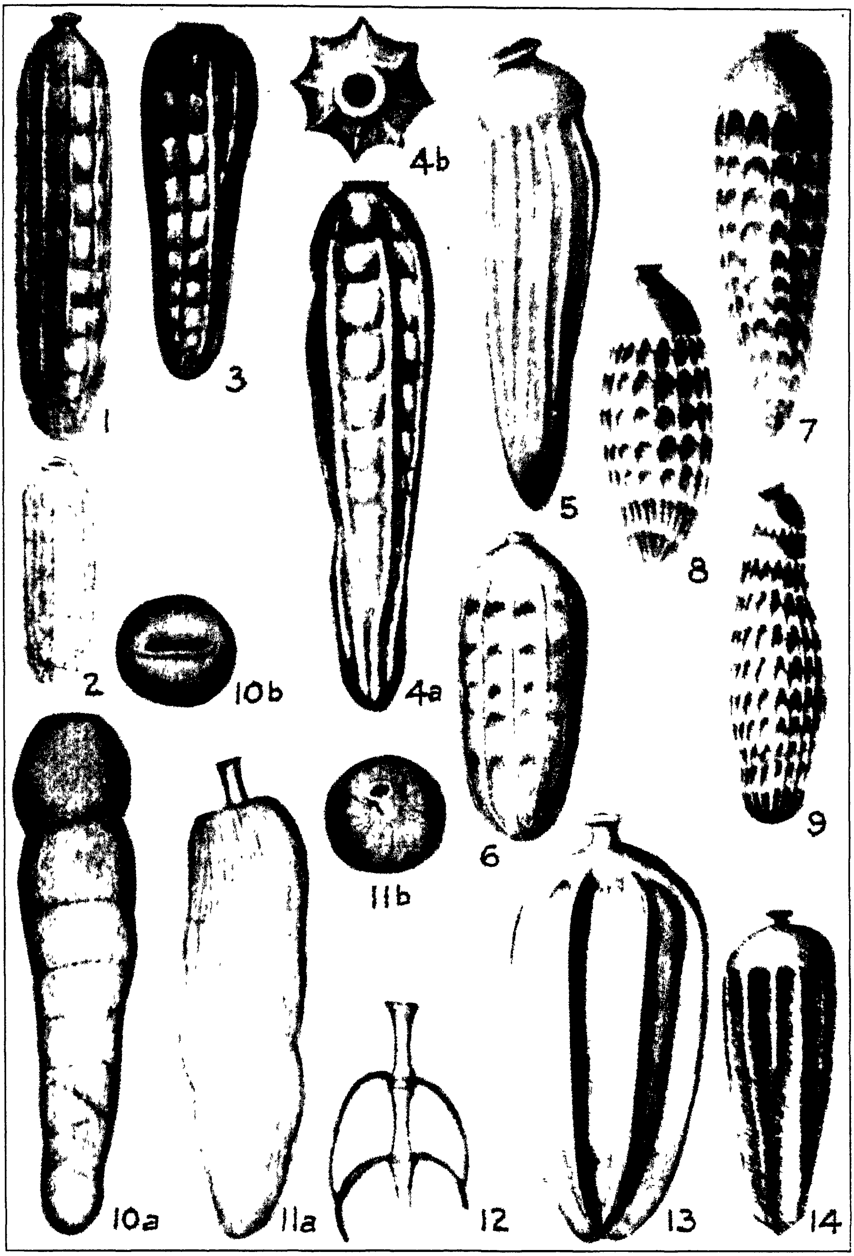
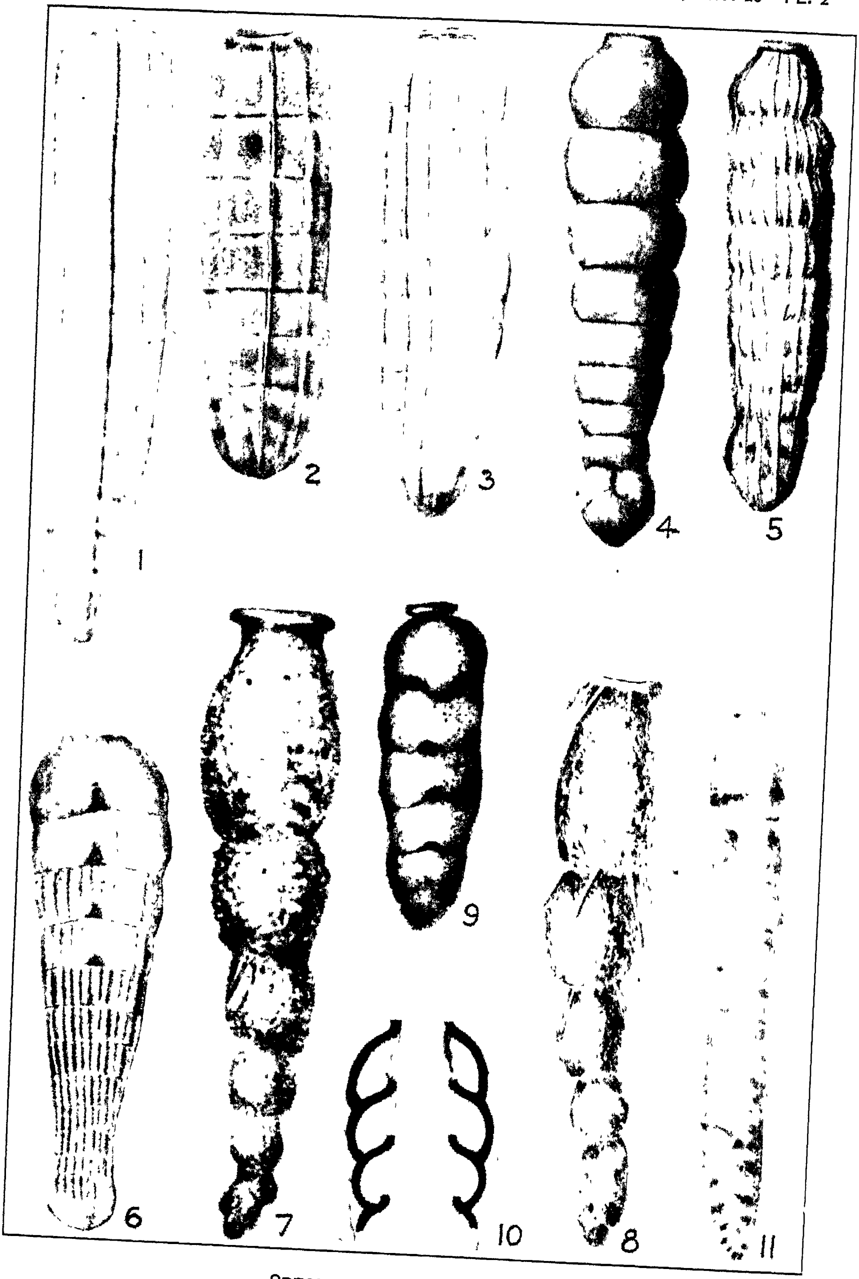


SPECIES OF SIPHOGENERINA

FOR EXPLANATION OF PLATE SEE PAGE 23



SPECIES OF SIPHOGENERINA

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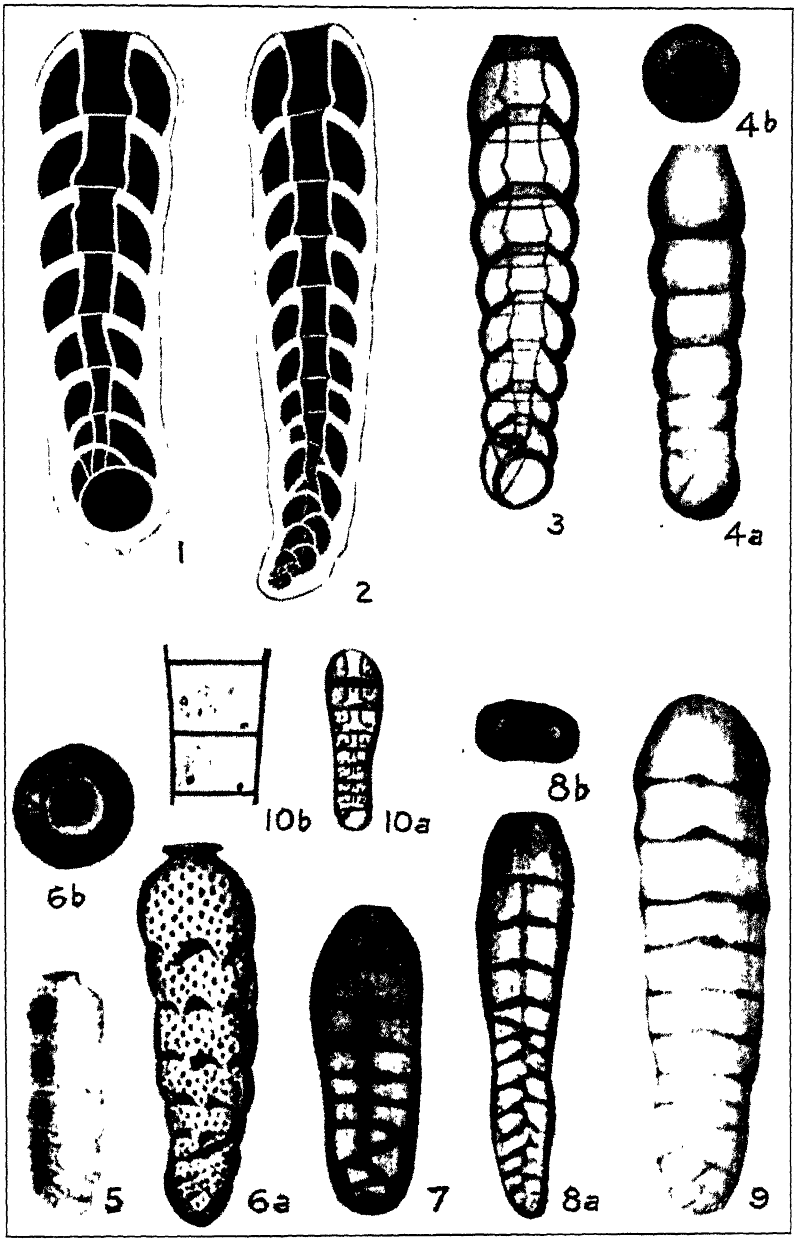
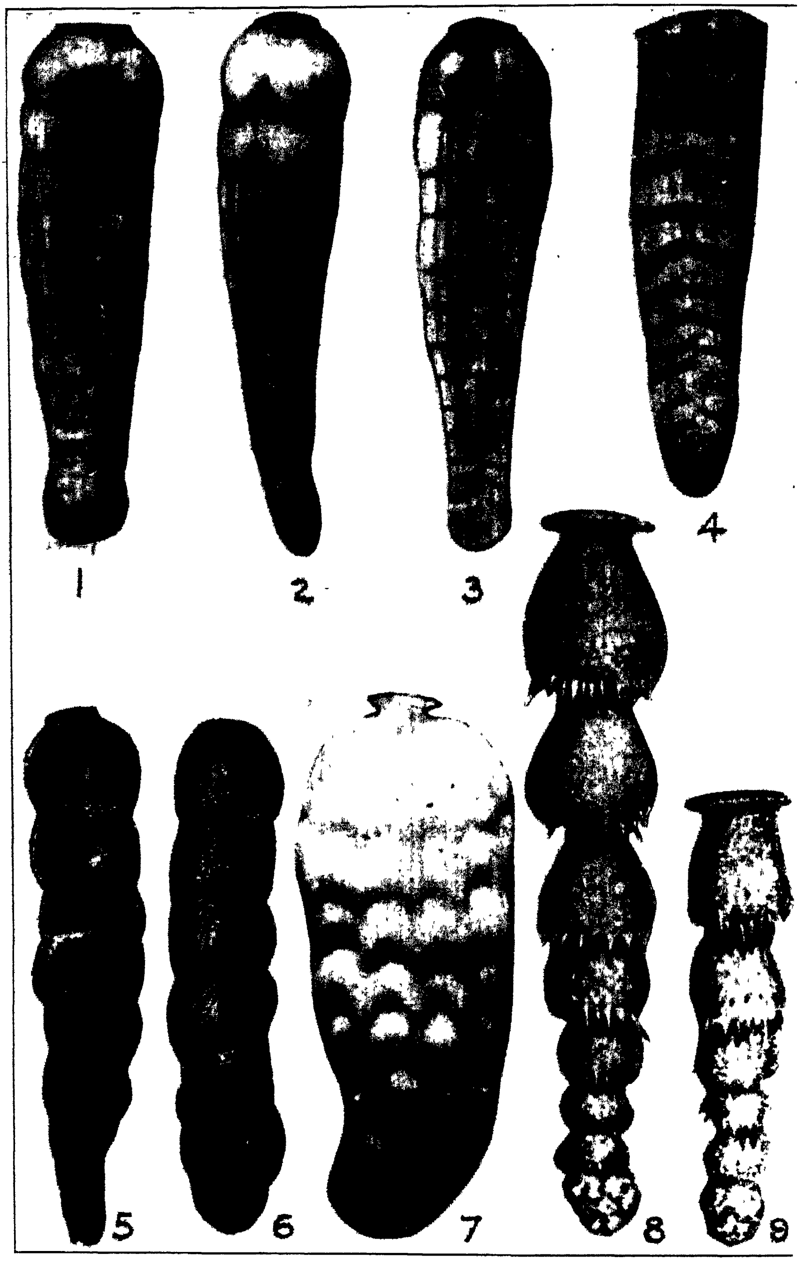


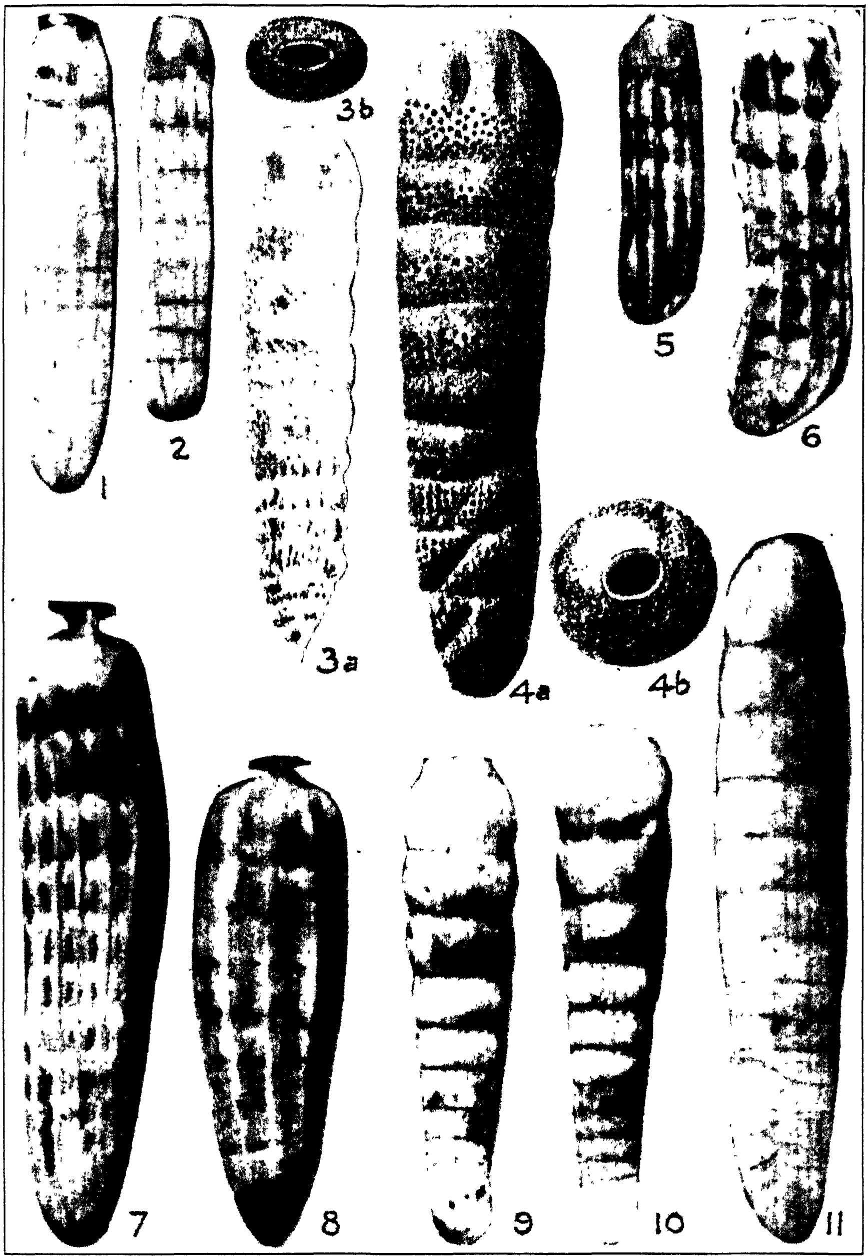
Species of Siphogenerina

For explanation of plate see page 23



SPECIES OF SIPHOGENERINA

FOR EXPLANATION OF PLATE SEE PAGE 24



SPECIES OF SIPHOGENERINA

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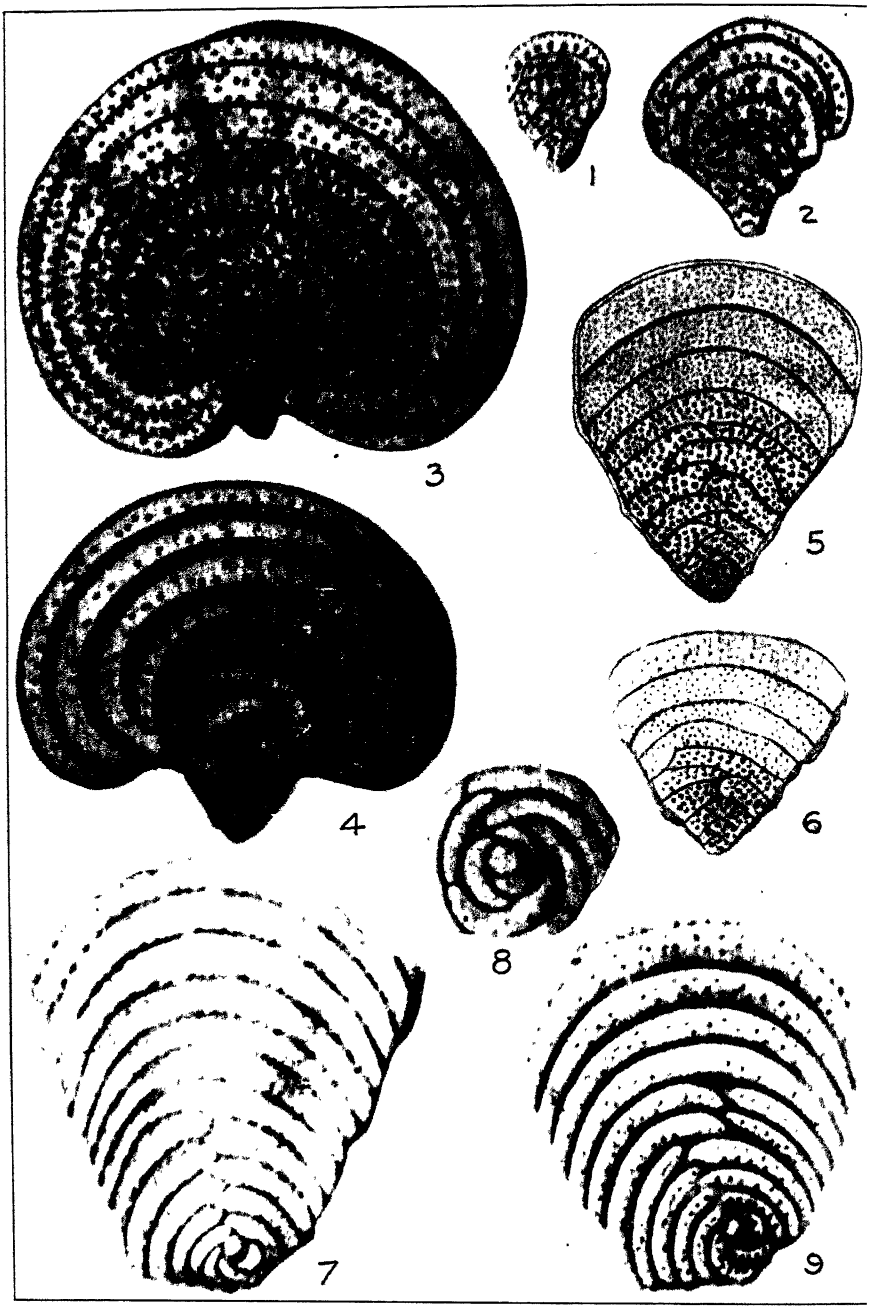


Species of Pavonina

For explanation of plate see page 24

# A NEW SPECIES OF HOOKWORM FROM A NORTH AMERICAN RACCOON

By Benjamin Schwartz

*Of the Zoological Division, Bureau of Animal Industry, United States Department of Agriculture*

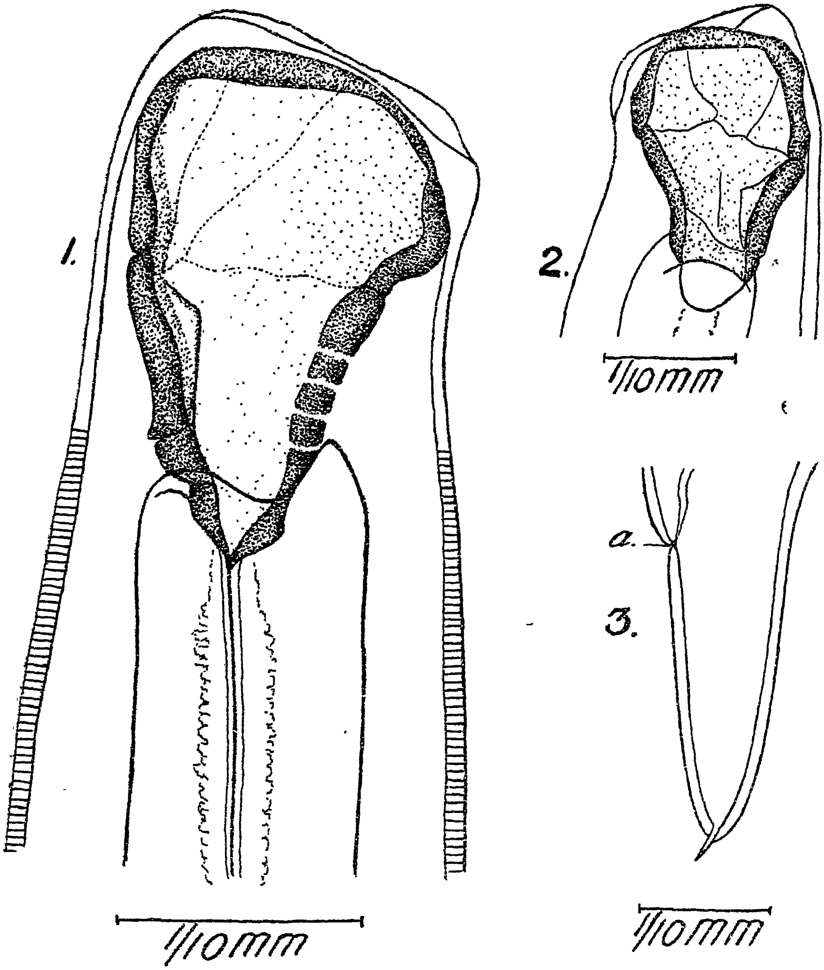
In the course of a post-mortem examination of a raccoon (*Procyon lotor*) that was captured in Prince Georges County, Maryland, on February 7, 1925, by Dr. W. S. Gochenour of the Bureau of Animal Industry, a number of hookworms were found in the duodenum. Associated with the parasites lesions resembling those usually produced by hookworms were observed in the intestinal mucosa.

Heretofore three species of hookworms have been recorded from raccoons of the genus *Procyon*. Molin (1861) has described *Dochmius bidens* and *D. maxillaris* from a South American raccoon (*Procyon cancrivorus*). These species were transferred to the genus *Uncinaria* by Stossich (1899). Baylis and Daubney (1923) have described a third species, *Tetragomphius procyonis* from a raccoon (*Procyon*, species) at the Zoological Garden, Calcutta, India. These authors note that their species may be identical with one of Molin's species but that Molin's descriptions are so incomplete that the species are unrecognizable. Like Baylis and Daubney the present writer has been forced to disregard Molin's species because the imperfections of the descriptions make recognition impossible. The form from *Procyon lotor* is therefore considered to be of a new species. For this species the name *Uncinaria lotoris* is proposed.

### UNCINARIA LOTORIS, new species

In their normal location on the mucosa of the intestine the worms were considerably twisted. After being placed in hot alcohol they straightened out. The cuticle is very finely striated transversely. The ventral wall of the mouth capsule presents a moderate curvature when viewed from the side (fig. 1). The mouth capsule is considerably longer than broad, its actual size varying in different specimens. In lateral view, the distance from the anterior extremity of the body to the base of the mouth capsule was found to vary from 162 to 216$\mu$

and the greatest width measured from the cuticle on the dorsal surface to the cuticle of the ventral surface of the head was found to vary from 107 to $144\mu$ in different specimens. The surface of the mouth capsule as observed in a lateral view of the worm, presents a number of sutures that divide it into five sections (fig. 2). Two sutures are transverse, the more cephalad suture being longer and extending across the anterior portion of the capsule, the other suture extending across the posterior portion of the capsule. Two sutures are longitudinal, extending from the anterior wall of the capsule to the more cephalad of the transverse sutures. The latter is irregular in shape



Figs. 1–3.—Uncinaria lotoris, new species. 1, Anterior end of worm viewed from the side. 2, Surface view of the anterior end of the worm, from the side, showing the sutures. 3, Posterior end of female. *a.*, anus; *d.*, dorsal ray; *e. d.*, externo-dorsal ray; *e. l.*, externo-lateral ray; *gub.*, gubernaculum; *l. v.*, latero-ventral ray; *m. l.*, medio-lateral ray; *p. l.*, postero-lateral ray; *sp.*, spicule; *v. v.*, ventro-ventral ray

and extends from what appears to be a joint in the dorsal wall of the capsule to a corresponding joint in the ventral wall of the capsule. The posterior transverse suture extends from what appears to be a joint in the ventral wall of the capsule and runs diagonally cephalad to the dorsal wall of the capsule but does not meet a joint. The sutures are best seen in a surface view of the capsule. They are not superficial grooves, but extend quite deeply into the capsule, and are still visible, in part, in deeper focus (fig. 1). In a lateral view of the mouth capsule the dorsal wall presents a series of narrow lacunae (fig. 1). In dorsal view these spaces appear as a series of circular openings arranged in two rows, one on each side of the dorsal gutter. In most specimens only from four to five openings can be distinguished on each side of the dorsal gutter. The number of distinguishable openings on each side of the dorsal gutter was found to exceed five in several specimens examined, the maximum number of openings that could be seen on each side being nine. The two ventral teeth are triangular in shape, the apex of the triangle being rather sharp. The esophagus is from 558 to 738μ long by 144 to 198μ in maximum width. The nerve ring is located at a distance of from 400 to 440μ from the anterior extremity of the body. The excretory pore is slightly posterior to the nerve ring and the cervical papillae are a little posterior to the excretory pore.

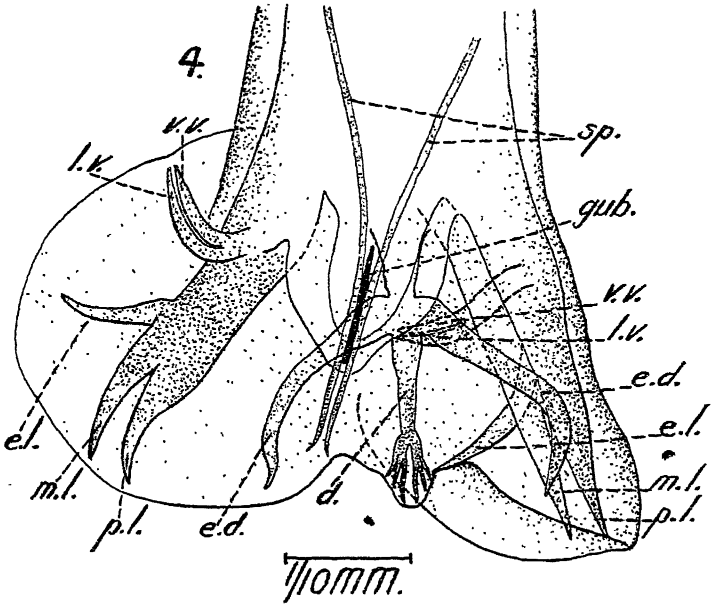


FIG. 4.—UNCINARIA LOTORIS, NEW SPECIES. POSTERIOR END OF MALE. FOR LETTERING, SEE PREVIOUS FIGURES

*Male.*—The male is from 5.5 to 6 mm. long by 234 to 254μ in maximum width. The lateral lobes of the bursa (fig. 4) are a little more than semicircular in shape. The postero-lateral ray is thicker than the medio-lateral ray. All the rays with the exception of the dorsal ray are more or less sharply pointed at the ends and do not reach the margin of the lobes. The terminal portion of the dorsal ray is bifurcated, each branch being tridigitate. The spicules are slender and tubular from 738 to 828μ long and terminate in finely pointed ends. The gubernaculum is an elongate slender structure about 90μ long.

*Female.*—The females are from 7 to 11 mm. long by 306 to 324μ wide. The position of the vulva corresponds approximately to the beginning of the posterior third of the body. The distance from the anus to the tip of the bristle that is inserted in the end of the bluntly rounded tail is from 180 to 234μ (fig. 3). The eggs are from 71 to 76μ long by 41 to 46μ wide.

*Host.*—*Procyon lotor.*

*Location.*—Duodenum.

*Locality.*—Prince Georges County, Maryland.

*Type specimen.*—U. S. National Museum, Helminthological Collections No. 26070.

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# ASYMMETRY IN THE SKULLS OF MAMMALS

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Reference to moderate asymmetry in human skulls is not infrequent throughout medical literature, but marked asymmetry in the crania of the other mammals (save the toothed whales, in which this state is the normal one) must be considered as a very rare condition. Careful examination of the material in any large collection would doubtless result in the discovery of a number of specimens showing some disparity between the development of the two sides of the skull; but it is exceedingly seldom that one occurs in which such condition is readily to be noted. Application to those in charge of some of the larger mammal collections of North America have produced but four specimens, two of which exhibit more emphatic distortion than seems ever to have been recorded.

Asymmetry in a skull may be brought about by a change in the size or relationship, through accident or disease, of the individual bones of one side of the head, an alteration, through the same agency, to one or more of the large muscles upon a single side, or a combination of these two factors. A further analysis of these reasons will suggest, as fundamental causes, a more or less permanently painful condition of some part of the head, as a sore tooth, a diseased, mandibular condyle, or other such state causing the animal to chew entirely upon the teeth of one side, or otherwise to use the muscles in an uneven manner so as to ease the pain of the offending part as much as possible. This at first is voluntary, although it may later become entirely involuntary, and it implies a long-continued period of painfulness of the part originally affected. Again there may be a definite alteration in the shape of a bone, through fracture and later healing in a twisted position, changing the interrelationship of other parts of the skull, as the mandible. Accidental severance of certain nerves may also be productive of similar results. In all such cases of asymmetry in the skull, initial injury at a comparatively early age is a necessity—the earlier the injury the more pronounced will be its effects, other things being equal.

The pathological conditions resulting from the healing of a severe injury to the bone after the animal has attained full growth does not

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here concern us, for any resulting asymmetry will be purely mechanical, affecting only the immediate portion injured, and probably having no appreciable effect whatever upon other portions of the skull. That this premise is founded on fact is shown by a skull of *Ursus eltonclarki* (No. 232382, Biological Survey collection) from Chichagof Island, Alaska. This is of an adult whose entire right coronoid process is missing. The bone healed well, proving that the injury antedated the death of the animal by a considerable period. Had this happened during the youth of the animal, the practical destruction of function of the right temporal muscle would have resulted in profound cranial changes, but there is now not the slightest asymmetry.

Attention should here be called to the study by Hollister[1] of the skulls of captive lions. In this it is argued that certain conditions—notably massiveness—to be met with in the skulls of lions raised in captivity are the result of myological stimuli, the muscles being effected by conditions brought to bear during captivity. If this be the case, then the criteria usually employed for judging the strength of a skull and its musculature must be altered. A thorough examination of Hollister's material[2] by the present writer, however, has produced new evidence and led him to the conclusion that the conditions obtaining in the skulls of these captives are pathological rather than myological.

Published references to asymmetrical skulls of mammals other than man include an experiment conducted by Anthony,[3] in the course of which he cut the left temporal muscle of a puppy upon the day of its birth. The dog, killed by accident when something less than one year old, showed marked atrophy of one temporal muscle, even in life; but the only really definite asymmetry to be noted in the skull is the absence upon the left side of the ridge which normally marks the medial boundary of the origin of the temporal muscle. The left, or "abnormal," zygomatic arch, as compared to the right, is less than 1 mm. deeper, less than 3 closer to the cranium, and is practically the same in length. The latter points are of interest as showing the trend of the abnormal side, but the differences are too slight to be of much significance in the present study.

The same investigator, as senior author,[4] experimented upon two more dogs at a later date, with results that duplicated his first efforts.

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[1] Hollister, N., Some effects of environment and habit on captive lions, Proc. U. S. Nat. Mus., vol. 53, 1917, pp. 177–193.

[2] Howell, A. B., Pathologic skulls of captive lions, Journ. Mamm., vol. 6, 1925, pp. 163–168.

[3] Anthony, M. R., Introduction a l'étude expérimentale de la morphogénie, Bull. et Mems. Soc. Anthr. Paris, 1903, no. 2, pp. 119–145.

[4] Anthony, M. R., et Pietkiewicz, W. B., Nouvelles expériences sur le rôle du muscle crotophyte dans la constitution morphologique du crâne de la face, Compt. Rend. Acad. Sci., vol. 149, 1909, p. 870.

There is described and figured by Paravicius[5] the skull of a dog exhibiting a marked dextral twist to the rostral region. Unfortunately, this specimen lacked the lower jaw, for the characters strongly indicate that the reason for the asymmetrical condition was the subnormal development of the right ramus of the mandible, due to a fracture during puppyhood. There is no appreciable asymmetry of the temporal fossæ.

Toldt[6] discusses the asymmetrical skull of a fox in the Vienna Museun. On account of a diseased condition of the left, lower, fourth, premolar the animal had used the temporal muscle of the right side as exclusively as possible. The myological condition resulting was a slight increase in the size of the right temporal, shifting its ridge a bit entad. Atrophy, or rather nondevelopment, of the left temporal was marked, its ridge developing considerably laterad of the normal position, and there is practically no lambdoidal crest upon that side. The left supraorbital process and the portion of the temporal fossa immediately caudad thereto, however, are shown in the illustration to be better developed upon the left side. A somewhat puzzling circumstance is the fact that in the drawing, the left zygomatic arch is shown to be about 2 mm. farther from the cranium than the right, while the text also mentions that the disparity is slight. This state of the left zygoma is at variance with what one would naturally expect to accompany a reduced temporal muscle. I imagine, however, that there was some special disparity between the masseter muscles to account for it—an hypothesis which can hardly now be proven.

An instance is mentioned by Leisewitz[7] of slight asymmetry in the skull of a monkey of the genius *Lagothrix*. The bilateral disparity is very poorly defined, however, and the author is mainly concerned with consequent slight differences in tooth wear.

The skulls at hand exhibiting definite asymmetry number four. Two of them are of primates, whose musculature of mastication is adapted to the absence of true glenoid fossæ, and hence, to a considerable movement of the mandible in all directions. The remaining two skulls belong to a single species of pinniped—a carnivore having true glenoid fossæ, which permits practically no lateral nor propalinal motion of the mandible.

## ASYMMETRICAL SKULLS OF PRIMATES

The writer is indebted to Mr. G. S. Miller, jr. for permission to study the skull of a form of gorilla in the National Museum collection (see pls. 3, 4, 5, and 6). This bears the data "No.239883, male,

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[5] Paravicius, G., Asimmetrie cranio fasciali in un cane, Atti Soc. Ital. scienze nat., 1902, pp, 349–352.

[6] Toldt, Von K., Asymmetrische Ausbildung der Schläfenmuskeln bei einen Fuchs infolge einseitigei Kautätigkeit, Zool. Anz , vol. 39, 1905, pp. 176–191.

[7] Leisewitz, W., Ein Beitrag zur Kenntnis der bilateralen Asymmetrie des Säugetierschädels, Sitzungs berichten der Gesells. für Morph. und Phys. in München, 1906, pp. 1–15

Africa, Belgium Congo, Rec'd. 1923, Benj. Burbridge." It is the skull of a large adult and is in good condition. The specimen is definitely asymmetrical, though not to a startling degree. The cause of this was due either to an injury to, or a diseased condition of, the right side of the head at a sufficiently early age so that the bones were still plastic. It may be mentioned that a slight, chalky deposit upon some parts of its surface is probably attributable to the method of cleaning rather than to a pathological condition of the bone. Direct indications of abnormality are as follows:

(*a*) A scarred condition and marked lateral shortening of the right mastoid, as well as of the neighboring exoccipital (measurements, foramen magnum to lateral extremity of mastoid; left, 72.2; right, 59.5 mm.)

(*b*) A malformation, encircling the right jugular foramen, of the petrous portion of the temporal and adjacent portions of the basioccipital.

(*c*) A marked deformity of the inferior wall of the right auditory meatus, including some change in the part of the squamosal immediately above, resulting in an enlargement of this passage and a lateral shortening of its inferior wall.

(*d*) An alteration in the condition of the right glenoid fossa, damage to, and partial restoration through healing of, the postglenoid process, and a pitted condition of the surface immediately craniad of the fossa.

(*e*) A shortening of the right condyloid neck of the mandible, with alteration in the shape, and pitting of the articular surface, of the condyle.

(*f*) The absence of the lower left canine, with complete healing and filling in with bony tissue of its alveolus.

(*g*) A recession of the alveolar margins and septa between some of the teeth.

The possible causes of these results should first be considered. Healing of all malformed parts has been complete. There are now no signs of old fractures and there is little evidence from which to decide whether the conditions are the result of disease or of an accident. If they be due to disease, then this is most probably the result either of a severe abscess, an infection of a local wound originally slight, or improbably to some true disease of the bone. If the original injury were due to an accident, then this was caused either by a bullet, which I am inclined to doubt, by a native arrow or spear, or the piercing of the fleshy parts by a sharp stick or stone during a fall from a considerable height. Even though the theory of an accident be accepted, then severe, local infection most probably followed.

Inquiring more fully into the pathological situations present it is found that—

(*a*) The right mastoid is unusual only in being shortened laterally and in having a marked process inferiorly. The lateral shortening of the whole right side of the occipital is probably because of injury to, and subsequent abnormal development of, the muscles originating upon the infero-lateral part of its surface.

(*b*) The deformity of the petrous portion of the temporal is not marked, aside from its misplacement. Its chief point of interest lies in the fact that there is almost complete closure of the jugular foramen and obliteration of its fossa, probably through the healing of a small, diseased portion of both the petrous and occipital margins of the foramen. The occipital was, perhaps, chiefly instrumental, for its border has extended farther forward than normal, and the petrous is correspondingly displaced. It is, of course, impossible that the jugular vein was suddenly severed, else the animal had died at once. Rather was its gradual atrophy brought about, enabling other veins to care for the venous blood that is normally carried by the right jugular. The functional alteration has not, however, resulted in any increase in the size of the left jugular foramen, for the latter is, in fact, smaller than seems to be usual in this genus.

(*c*) The condition of the right auditory meatus indicates much damage to the inner ear, very possibly causing complete deafness upon that side, induced by severe suppuration of the parts. The passage is greatly enlarged, both superiorly and inferiorly, being about 13 mm. in diameter, as against 7 for this measurement of the left passage. The lateral length of the inferior border of the meatus, measured from the carotid foramen, is about 18 mm. shorter upon the right than the left side. This was evidently brought about by suppuration and partial absorption of the bony lining of the meatus, with subsequent healing and growth of new bony tissue only upon its outer or inferior face.

(*d*) The right glenoid fossa proper is not greatly altered, but the eminentia articularis, anteriorly adjoining, is flattened and much pitted. The same condition of pitting obtains upon the squamous eminence adjoining the process of the tensor palati. The conditions to be observed in the glenoid region are naturally correlated with the following:

(*e*) The right articular surface of the mandibular condyle is flattened, broadened in an antero-posterior direction, and much pitted and roughened, and the neck, as measured from the base of the coronoid process, shortened by about 7 mm. It is very likely that the functions of the abnormal side of the jaw were even more severely interfered with than can now be told from an examination of the skull, through destruction of part of the condyloid ligaments.

(*f*) There is no possibility that the left lower canine was congenitally absent, for the tissue now occupying the position of the normal alveolus is, in texture, different from the surrounding bone. This scar seems to be slightly smaller than the alveolus of the right canine, indicating that the left was lost some time during the youth of the individual. Another indication that the tooth was not lost in later life is that the healing of the alveolus would then hardly have been as perfect. The surrounding bone is smooth and healthy, and the prominence upon the chin formed by the root of the normal canine is absent upon the left side. There is no indication of how or why this tooth was lost.

(*g*) Many of the alveoli are markedly pathologic. This condition takes the form of excessive shrinkage, or lowering of the bony border, and is most marked in the septa between the tooth rows, especially between the second and third molars of both sides and the first and second of the left side, of the lower series; and between the second and third molars of both sides of the upper series. The majority of the remaining molariform teeth of the upper series are also affected, but in lesser degree. The bone involved is smooth, however, showing no sign of scars or injury, and the abnormality was not caused by suppuration.

A study of the above situation and a consideration of all possible solutions points with probability to an intensely interesting explanation. At the age when this individual had just cut the front teeth of the permanent set, he suffered an injury, most likely followed by inflammation of the muscles of the right side of the head and neck. For an indeterminate interval thereafter the act of chewing food, and very likely that of swallowing as well, was so painful that the animal brought itself to the verge of starvation. From this cause, a state of malnutrition followed, reaching its maximum severity at a time during or immediately subsequent to the cutting of most of the rear molars, which occurs some time after the appearance of the anterior teeth of the permanent set. Any deficiency in the diet having an osteological effect at the time that tooth change is occurring would manifest itself at just this point, where the process of absorption of old, and formation of new, bony tissue renders this part most subject to any adverse influences. It is likely that the permanent cheek teeth were rather well formed when the condition of malnutrition was most acute, however, else their emplacement would show some abnormal irregularity, which is not the case. The state of the posterior borders of the alveoli of the third molars or "wisdom" teeth points to the conclusion that before the appearance of the latter, the animal had ceased to suffer pain, had resumed a normal diet, and had thus terminated the period of malnutrition.

An alternative hypothesis, in no wise dependent upon the original injury to the skull, was suggested by Capt. R. W. Leigh (MS), of the Army Medical Museum, to account for the alveolar condition. This is to the effect that the molariform teeth grew into position with abnormally large spaces between them, into which became more or less permanently wedged particles of fibrous foods, this finally forcing the recession of the alveolar borders. I have occasionally noted just this state of affairs between two or three teeth of ungulates and rodents, and I deem it very likely that the same situation operated to aggravate the abnormal condition in the gorilla; but that this was the original and sole cause for the recession of the bony borders I strongly doubt.

An examination of the skull impresses one with the probability that certain muscles suffered considerable violence, either directly or in consequence of severe infection after injury. The evidence indicates that the muscles thus involved were chiefly the digastric, trachelo-mastoid, sterno and cleido-mastoids, splenius, rectus capitis lateralis, and the levator and tensor palatis. It is not improbable that the obliquus superior was also affected. There is no satisfactory evidence that any other muscle suffered directly except in so far as the pathological condition of the articulation of the right side of the jaw means previous infection, to some extent, of the muscles surrounding it.

The direct results of injury, reflected in the stresses exerted by other muscles of the head, were of a more profound and lasting character. Injury to and subsequent healing of a muscle causes, under certain conditions, shrinkage of its length, and other strains may develop. It should here be understood that the term "pull" of a lesioned muscle, "shrinkage," etc., is merely relative and not actual. Shrinkage is very seldom sufficient for a muscle so affected to exert true tension upon a part; but a muscle of this character not only resists full relaxation, but by the same token resists normal growth. Hence, for all practical purposes, it does not matter, when speaking of a case where asymmetry of a bone is due to difference in the development of either of a pair of muscles, whether one conceive that the abnormal side of a bone has been pulled around by contraction (*i. e.*, resistance to normal growth), or that the growth of the normal side has pushed the other out of line.

With respect to the long axis of the skull, the foramen magnum is displaced toward the right in such a manner as to suggest that the articulation of the condyle with the atlas was forced in that direction, logically, by the pull of the lesioned obliquus superior and rectus capitus lateralis, and perhaps other, muscles upon that side. The basioccipital naturally is obliged to follow this tendency, and it is similarly displaced, but the other sutures of the occipital are not traceable. Because of the fact that so few of the individual bones of the cranium can be defined, it is impossible to tell whether the lateral shortness of the right mastoid and exoccipital, which also means the lambdoidal crest upon this side, is due entirely to the effect of the cervical muscles involved, or also to that of the temporal. In all probability both have contributed to the existing state of affairs. It also seems likely that the right cervical musles previously enumerated were relatively weak.

The medial portion of the right petrous temporal has been advanced several millimeters, with corresponding displacement of the origins of the palati muscles. The origin of the right internal pterygoid is larger than the left, but the difference is not of greater degree than occurs in symmetrical skulls. The right curve of the palatal shelf extends slightly farther craniad than the left, indicating a corresponding disparity between the insertions of the two tensor palati muscles.

An examination of the superior aspect of the skull at once discloses the fact that the right temporal fossa as a whole is considerably smaller than the left. It is not less deep, to any appreciable extent, but the sagittal crest is displaced toward the right and the right lambdoidal crest is shorter. The fact is disclosed, however, that the anterior part of the right temporal was of greater mass than upon the left. This resulted in the displacement, in both anterior and lateral directions, of the right frontal, now best shown by the position of the supraorbital ridging. The origin of this part of the muscle is thus more extensive upon the right side, and it may well have been thicker also.

For certain work the right side of the jaw must have been favored to a marked degree. The right condylar articulation was either permanently painful when stressed, which I am inclined to doubt, or what is more likely, there was some mechanical handicap to its use, such as lesions of the ligaments or condylar capsule, causing the animal to rely largely upon the left side of the jaw. It seems certain that this is the proper explanation for the fact that the posterior part of the right temporal muscle was smaller than the left. The fact that the anterior part of the right temporal was larger than the corresponding portion of the left is somewhat unexpected. It would be entirely logical were the temporal muscle divisible into an anterior and a posterior part, but according to Sonntag[8] the division is rather into a superficial and a deep portion. The vacuity of the temporal fossa, inclosed by the zygomatic arch, is shorter and broader (transversely) upon the right side, and as the two zygomatic arches are otherwise of equal development, it is impossible now to be sure whether the muscles passing beneath (within) the arch were of greater bulk upon one side than the other, or whether the masseter of one differed somewhat in development from its fellow.

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[8] Sonntag, C. F., The morphology and evolution of the apes and man, London, 1924, pp. 1-364.

The right coronoid process is about 5 mm. longer than the left, but this is due to the fact that the mandibular notch is correspondingly lower upon that side, and not to differences in the lower-border-to-coronoid measurement. The reasons for this state of affairs are too obscure and complicated for satisfactory interpretation.

At first thought it would appear that the displacement towards the right of the rostrum is attributable to the effect of the teeth of the mandible having been pulled in that direction by the action of the asymmetrical muscles attached to the latter. Although it seems that this hypothesis should be the logical one, a closer scrutiny of the existing state of affairs demonstrates that the rostrum (*i. e.*, the portion of the face craniad to the frontals and orbits) primarily has been deflected towards the right. The reason for this rostral movement is obscure. As there are no powerful muscles connected with this region, it can only be presumed that the displacement was in response to certain muscular forces operating asymmetrically upon the bones with which the rostrum articulates. It is clear that the mandible, through its condylar articulation, has resisted this dextral trend of the rostrum. The lower border of the mandible exhibits a tendency to remain in normal position, while the alveolar margin, in response to the force exerted by the teeth of the rostrum with its dextral twist, is also twisted towards the right.

Extremely grotesque is the skull of a monkey (pls. 1 and 2)—*Lasiopyga griseoviridis* (Desmarest)—for the loan of which I am indebted, through Dr. G. M. Allen, to the Museum of Comparative Zoology. This is a fully adult male (No. 15720, Mus. Comp. Zool.), bearing the data "Sudan, Blue Nile, Magangani, 29 Jan., 1913, Phillips Sudan Ex. 1913, Col. G. M. Allen, J. C. Phillips, orig. 84". Recent injuries, received by the skull at the time when the specimen was collected, consist of the breaking away of a part of the upper alveolar border, including the two left incisors, and injury to the right temporal, including mastoid, auditory and squamous portions. Old osseous scars comprise a fracture of the nasal bridge, which probably has had no effect upon the conformation of the skull, the absence of the right lateral, maxillary incisor, broken off at the root, and the absence of the entire posterior portion of the left ramus of the mandible. including angular process, the whole condyle, and all but the extreme anterior border of the coronoid process. There is no indication of disease, so it is likely that the mandibular fracture was due to an accident of some sort, such as a glancing rifle ball or a long fall. The portions of bones detached were either absorbed, or sloughed off through an open wound. It is certain that this occurred when the animal was less than half grown, or probably very young.

The injury immediately caused a profound alteration in the mechanism of the lower jaw. As fully half of the bone upon the left side measuring from the last molar to the condyle, was lost, there was no articulation between the mandible and that side of the skull, and the only motion possible was a sort of rotation of the lower jaw. It is certain, of course, that the mouth could be opened sufficiently for the insertion of required food, but it is hardly likely that possible movement was sufficient to enable the animal to use its canines for any practical purpose. The lower canines to some extent, and the upper ones especially, are developed in length well beyond what is normal in this genus. The mandible is further characterized by a stunted or infantile condition of the left ramus, which results in an abnormal, crowded position of the third molar upon that side. The balance of the asymmetry exhibited by the mandible is due to the more normal growth of the right ramus and the twisting effect exerted, through the teeth, by the maxillary deformities.

In considering the form of the skull proper it must first be remembered that the insertions of the left pterygoid muscles have been totally destroyed, and those of the left temporal and masseter, largely so. To just this extent are the effects of these muscles upon the skull destroyed, except as there may have been fractional, aberrant functions through chance secondary attachments.

The supraorbital ridging and the relational position of the two orbits may be said to be the only symmetrical part of the skull The occipital plane also shows practical symmetry, although the basioccipital does not.

The growth of the right side of the skull has been as nearly normal as the limitations of the left side would permit. This has resulted in a disproportionately swollen appearance of the right side of the cranium, and in a sharp twisting of the face to the left. A somewhat fantastic, though expressive, way of describing the present effect is to imagine the juvenile skull as having been made of soft rubber, held rigid in the vicinity of the left zygomatic process of the maxilla, and the rest of the skull then inflated and expanded. This appearance, as previously mentioned, has been attained through nongrowth of the left side. All parts of this side have remained infantile, especially the length of the zygomatic arch, which has ensued upon the virtual destruction of functions of the muscles of mastication upon the left side.

One result of the infantilism of the maxillary border upon the left was the failure of the alveolar row to increase in length, with the consequence that insufficient room was provided for the normal emplacement of the permanent first molar. This has resulted in the inward and upward growth of the roots of the tooth and the alteration of its shape.

Of significance is the practical nondevelopment of the outer pterygoid plate upon the left, following the destruction of function of the muscles normally attached to it. A more detailed description of the individual bones of the skull, although of interest, is hardly sufficiently instructive for presentation here.

## ASYMMETRICAL SKULLS OF PINNIPEDS

It is through the kindness of Dr. J. Grinnell that the writer has been enabled to study the pathological skull of a sea lion from the collection of the Museum of Vertebrate Zoology (pls. 5, 6, and 7). This is a male specimen of *Eumetopias jubata* (Schreber), adult but not aged, and evidently somewhat stunted by its condition. It now bears the data "No. 4964, Museum of Vertebrate Zoology, July 2, 1907, Ana Nueva Id., California, John Rowley, 257." In asymmetry it is far more spectacular than the skull of the gorilla already discussed, but its condition is considerably easier of interpretation.

The specimen was probably shot, as evidenced by a hole in the right frontal and a larger one obliquely opposite within the orbit. In addition it seems that the skull has since been dropped upon a hard surface, for the cranium is badly fractured. John Rowley, the collector of the specimen, writes (MS) that it "was apparently as fat and husky as any of the others." The only evidence of old scars upon the skull is to be found in the posterior half of the left zygomatic arch, and upon the medial portion of the left glenoid fossa. It is possible that there was also partial fracture along the suture formed by the left jugal with the maxilla, for this is now obliterated, whereas it is strongly defined upon the opposite side.

Although no full tables of measurements of the four skulls herein discussed have been thought necessary, a number of the most significant ones of the abnormal sea lion, compared with a normal one which is somewhat larger, but probably of about the same age, are found to be of interest.

| | | Injured male | Normal male |
|---|---|---|---|
| | | *Mm.* | *Mm.* |
| Total length | | 331 | 369 |
| Rostral width | | 96 | 88 |
| Exoccipital to anterior border of canine | right | 295 | 313 |
| | left | 258 | |
| Length of jugal | right | 150 | 150 |
| | left | 127 | |
| Total length mandibular ramus | right | 267 | 278 |
| | left | 249 | |

It is clear that the original injury was received by the animal when the bones were extremely plastic. It is equally apparent that the injury was in the nature of a smart blow upon the side of the head, such as might have been received by a fall from a ledge upon a sharp rock some distance below.

The occipital bone is entirely symmetrical, but this, perhaps with the pterygoids, is the only portion of the skull of which this may be said.

Beginning at the point of original injury, it is seen that the jugal has been fractured in at least one and possibly two places. This, however, as well as the distal end of the zygomatic process of the squamosal, is now so distorted that but little can be told from it. That the injury took place during the very early life of the animal can be seen not alone by the general distortion, but from the fact that the left zygomatic arch is very much stunted; not that it is shortened, of course, but that it has failed to grow at anywhere near the normal rate. An examination of the glenoid fossa upon this side discloses the fact that the medial portion of its concavity is granular and distorted in form. There was assuredly further injury at this point, and some sort of fracture or derangement of the precise relationship between the bones immediately caudad, so that they failed to grow at the normal rate. This certainly seems to be the sole extent to which the skull was directly injured, all other details of asymmetry having been due to indirect influences.

An early and complete fusion of the adjacent sutures evidently followed the injury to the last-mentioned region, which resulted in a permanent stunting of this portion of the skull. The left auditory and petrous part of the temporal are especially affected, being small and misshapen. The resistance to growth may have been augmented by the pressure of the left mandibular ramus against its glenoid fossa, caused by increasing displacement of the rostrum, although this was not the primary factor in causing the condition. The distance between the left zygomatic process of the squamosal and the normal mastoid is but 4.5 mm., while the same distance upon the right side measures 18 mm. As the mastoids, occipital, and lambdoidal crests are entirely normal, or at least symmetrical, it is seen that there is a sharp bending of the cross axis of the skull, through the glenoid fossae, of four degrees. This, carried at right angles to the anteriormost point of the mandibular symphysis, would show a lateral deflection from the normal axis of the skull (as projected at right angles to the occipital plane) of about 20 mm., even were there no other asymmetrical forces operative. As a matter of fact, other conditions have contributed to increase this deflection so that it actually approximates 65 mm., as near as can be calculated.

The above theoretical deflection of the symphysis by 20 mm. is purely mechanical in character. All the remaining forces of asymmetry that have operated to alter the skull are either myological or developmental (growth of bone).

An examination of the superior aspect of the skull indicates that in comparison with normal crania the one under discussion seems to be unusually small, as well as can be judged from general criteria of age. Not only is it short, but the sagittal crest is more poorly developed. The cephalic musculature was therefore undoubtedly below normal, although one may presume that it was entirely adequate for the feeding needs of the animal.

The sagittal crest is displaced about 10 mm. toward the left, but with this exception there is no decided indication that the posterior portion of the right temporal muscle was more powerful than that upon the left. There is striking evidence to this effect, however, in the anterior part of the right temporal fossa. As clearly shown in the illustration, this portion of the right temporal was several times the larger, not only displacing the sagittal crest but extending well forward upon the frontal and modifying the shape and size of the right supraorbital process. The sinistral displacement of the rostrum is largely attributable to the disproportionately great development of this part of the muscle, coupled with the fact that the right zygomatic arch and masseter were free to accomplish anterior growth. On the other hand the stunting of the left zygomatic arch resisted normal growth of the left half of the skull, and necessarily limited the size of the mass of muscle that could pass within the zygomatic vacuity of the temporal fossa. These would seem to be the two causes that tended to limit the growth to the left temporal muscle, while the reduced length of the zygomatic arch upon that side prevented normal growth, and undoubtedly strength, of its attached masseter. Thus, during the development of the animal, the root or base of the left side of the rostrum was held back, while that of the right side was pushed forward, resulting in the great displacement toward the left exhibited by that part of the skull. Another consequence has been the disproportionate, dextral bowing of the mesethmoid, and undoubtedly of the cartilaginous septum, which resulted in a crowding of the right ethmoid and, therefore, expansion of the left nasal passage, from which the ethmoid is now missing. This whole process has naturally effected a disproportionate development of the individual bones of the rostrum which is of interest; but there is no necessity here for dwelling at greater length upon their individualities.

Returning to an examination of the mandible, one notes that there is no indication of asymmetry in its muscular insertions. It is clear, however, that the displacement of 20 mm., caused by the shifting of the left glenoid fossa, has been much augmented by the rostral twist. In fact the latter is so great that the mandible has resisted it, through the interlocking of the teeth. Thus, the mandibular canines have been forced to incline toward the left, while the maxillary canines and lateral incisors have been pushed toward the right. The result is that although the rostrum as a whole turns strongly to the left, the anterior portion of its alveolar border exhibits a slightly dextral counter twist. The mandible reflects the varied stresses in a form difficult to describe with accuracy, but to attempt to do so is hardly necessary.

Another skull of *Eumetopias jubata* showing some asymmetry was also discovered. This is No. 131895 of the United States Biological Survey collection, and bears the data " ♀, California, Santa Cruz Id., W. J. Hockmeier, 4386X." It is of an adult, though not aged individual (pl. 8). The original cause leading to present asymmetry was a pathological condition of the left auditory and petrous temporal, which are now misshapen, with rough surfaces, and a large perforation inferiorly. An abscess probably constituted the original cause. The result has been a stunting of the region involved, and the distance from craniad of the glenoid fossa to the paroccipital process is 7 mm. less upon this side than the right. The zygomatic arches are also involved, probably through lack of normal growth of this process of the left squamosal, for the left arch is about 6 mm. shorter than the other. This, in turn, has evidently been instrumental in limiting the growth of the anterior portion of the temporal muscle, as clearly shown by the differences in the development of the supraorbital processes and the ridging between them. The remainder of the temporal fossae do not show any appreciable disparity, however.

Very slight asymmetry exhibited by the posterior half of the rostrum is probably due to dissimilarity in the development of the two zygomatic arches and the temporals, while the decided sinistral twist of the rostral extremity is attributable, through the interlocking of the canines, to the displacement of the left glenoid fossa, and hence, the mandible.

An interesting point which can hardly be explained entirely by the foregoing conditions is asymmetry in the occipital region. This is precisely the opposite of what might be expected, for the distance between the foraminal margin of the occipital condyle and the paroccipital process is, upon the left, 61, and on the right, 54 mm. It is due to growth of the left paroccipital process and the exoccipital rather than to displacement of the foramen magnum. One might hazard the opinion that it is the result of a compensating development of the attached muscles, as the digastric, or to some pathological condition of the cervical region; but all such hypotheses are pure speculation.

## CONCLUSIONS

From the study of these four specimens it has been concluded that the primary cause inducing asymmetry in the skulls of mammals other than toothed cetaceans is probably, in most instances, by accident or disease, to the bones or muscles of a single side of the head at a comparatively early age, and that this must be of such a character as to result in a stunted or infantile condition of a crucial part of the bony framework, and a reduction in the rate of growth, or strength through lesions, of the muscles of a single side. Asymmetry usually is directly dependent upon unevenness in the strains developed upon the two sides of the head while an animal is eating.

Certain injury to the bones of the head causes a premature obliteration of the sutures, as already indicated. Published data respecting human crania have shown that such early obliteration of the sutures may also occur from obscure causes without violence having been suffered by the individual. It is doubtless fortuitous that no skulls of this character have been available in the present study. Conversely, it is known that retarded obliteration of certain sutures beyond the usual time for their disappearance results in the hypertrophy of the corresponding part of the skull. It is only a question of time before material illustrating the latter point in the mammalia other than man is brought to light.

One of the most conspicuous results of this investigation, and one that deserves to be stressed, is the conclusion that normal development of the bones of the skull is directly dependent upon the growth of the attached muscles. In other words, if for any reason the muscles of an animal remain infantile and fail properly to grow, the bones to which they are secured will remain proportionately undersized. This assertion can not be proven in the case of the masseter muscles until the myology of asymmetrical skulls can be more fully investigated. It is also apparent that the smaller the origin or fossa of a muscle the smaller must the muscle itself be.[9] The significance of these facts, when considered with reference to specific (and higher) variation of the skull, is profound.

It is apparent that asymmetrical development of a skull inclines to progress both forward and backward from a center that is rather uniform. In other words, it always appears as though a part of the skull were held stationary while the portions craniad and caudad

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[9] Of interest in this connection is a paper by J. A. Howell (An experimental study of the effect of stress and strain on bone development, Anat. Rec., vol. 13, 1917, pp. 233–252) comparing the leg bones of a dog, the muscles upon one side of which had been transected when the animal was very young. The diameter of the bone was very greatly diminished thereby, but its length was but little below normal.

were both forced either to the right or to the left. This center is not precisely the anterior one of the three segments of the cranium proper, as has been claimed,[10] but the "dead center" may be considered as passing through the frontals above and palatals below. Either of these pairs of bones may vary somewhat in accordance with the portion of the skull either craniad or caudad thereto, according to whether the more powerful influence lies in one direction or the other. In the four skulls examined the original seat of injury has been in the neighborhood of one of the glenoid fossae.

It is difficult, if not impossible, to speculate with any degree of certainty upon the relative development of the temporals and masseters, considered as separate muscles, because of their extreme interdependence. The previous condition of the masseters can only be deduced from the configuration of the zygomatic arch. Reduction in the size of one temporal muscle is not necessarily followed by a smaller zygomatic arch, and therefore by inference, a smaller masseter upon that side; but reduction, for any reason, of the size of the arch does seem to result in a lessened volume of the adjacent temporal muscle.

The interrelationship of the anterior with the posterior portion of the temporal muscle is somewhat obscure, but fluctuations in the size of this muscle are not necessarily uniform for the two parts. The size of the anterior portion of the temporal fossa—lying immediately adjacent to the supraorbital processes in carnivores—may be very much larger, indeed, upon one side when the posterior portion—overlying the brain case proper—is but a trifle more extensive than upon the opposite side. The explanation of this fact is believed to be that the extreme cranial portion of the temporal muscle is the part that is used in contributing the ultimate contracting power of which the jaw muscles are capable. As this final force can hardly be applied upon the weaker side of the head, because of pain or mechanical disability, nondevelopment of the anterior part of the temporal muscle upon that side of the cranium results. Certain it is that a disparity in the development of the anterior, as compared with the posterior, part of an abnormal temporal fossa recurs sufficiently often to indicate a substantial difference in the precise functions of the two corresponding portions of the temporal muscle.

The pterygoid plates and fossae naturally reflect the development of the pterygoid muscles, and a smaller plate upon one side means that the muscles attached thereto were correspondingly weaker.

Asymmetrical development of the rear half of the skull—at least of the superior portion—is closely correlated with size and strength of the temporals and masseters, but such a condition of the face,[11] when marked, can not be due primarily to myological stimuli. It may be attributable first to a setting out of plane, through nongrowth of one side, of the bones with which the rostrum articulates, as a house may be thrown out of plumb by the settling of one side of its foundation; or it may be due to the pull, through the interlocking of the canines, primarily exerted by a glenoid fossa, and hence the mandible, which has been displaced.

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[10] Howell, A. B., Individual and age variation in Microtus montanus yosemite, Journ. Agric. Research, vol. 28, 1924, pp. 977-1016.

Asymmetry of the occipital plane may be ascribable in part to differences in the size of the lambdoidal crests induced either by the temporal muscles, or by variation in certain of the cervical muscles, or both. As only the insertions, and not the origins, of the latter are available for examination, interpretation of the few facts presented is difficult.

The form of an asymmetrical mandible is determined mostly by the positions of the glenoid fossae at one extreme, and by the force that may be exerted by the interlocking canines at the other. Variation in size between the mandibular processes of the two rami is not likely to be as great as are certain asymmetrical differences in the skull proper. In other words, the muscular origins seem to be more sensitive to asymmetrical influences than are their insertions. Asymmetry of the mandible, in fact, seems to be due chiefly to mechanical stimuli.

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[11] For convenience the posterior portions of the zygomatic processes of the maxillæ are here considered as not belonging to the face proper.

## EXPLANATION OF PLATES

### PLATE 1

Upper figure, dorsal view of mandible; and lower figure, ventral view of asymmetrical skull of monkey—*Lasiopyga griseoviridis* (No. 15720, Mus. Comp. Zoöl.).

### PLATE 2

Upper figure, frontal view; and lower figure, dorsal view, of asymmetrical skull of *Lasiopyga griseoviridis.*

### PLATE 3

Ventral view of asymmetrical skull of gorilla—*Gorilla beringei mikenensis* (No. 239883, U. S. Nat. Mus.).

### PLATE 4

Upper figure, right, lateral view of maxillary molars; and lower figure, dorsal view, of asymmetrical skull of gorilla.

### PLATE 5

Upper figure, frontal view of asymmetrical skull of gorilla. Lower figure, frontal view of asymmetrical skull of male sea lion—*Eumetopias jubata* (No. 4964, Mus. Vert. Zoöl.).

### PLATE 6

Upper figure, dorsal view of mandible of asymmetrical gorilla. Lower figure, dorsal view of asymmetrical mandible of male sea lion (No. 4964, Mus. Vert. Zoöl.).

### PLATE 7

Upper figure, dorsal view; and lower figure, ventral view, of asymmetrical skull of male sea lion (No. 4964, Mus. Vert. Zoöl.).

### PLATE 8

Upper figure, dorsal view; and lower figure, ventral view, of asymmetrical skull of female sea lion—*Eumetopias jubata* (No. 131895, Biol. Surv. coll.).

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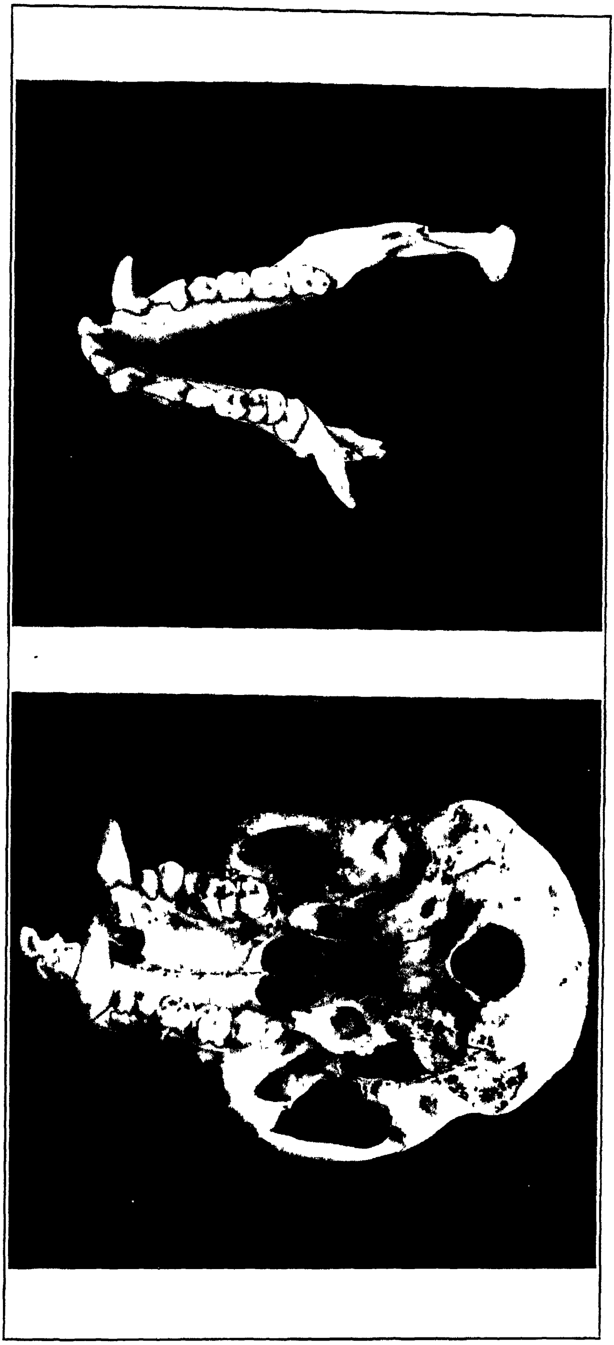
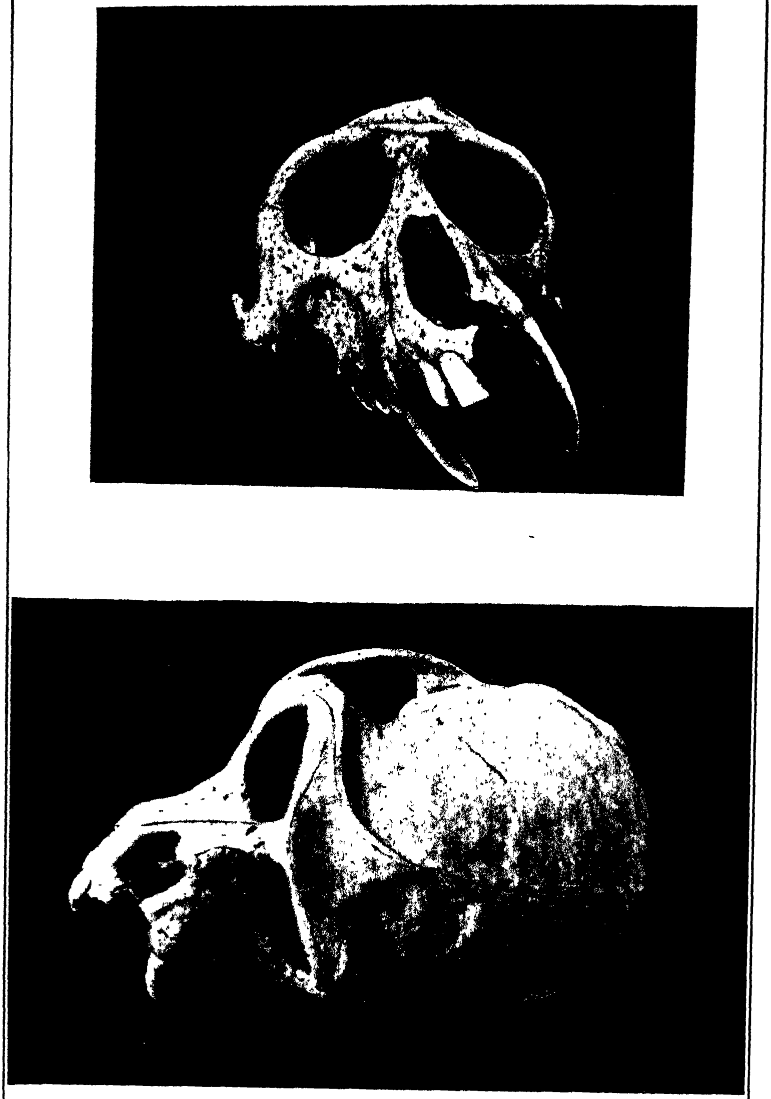


SKULL OF MONKEY, LASIOPYGA GRISEOVIRIDIS

FOR EXPLANATION OF PLATE SEE PAGE 18



SKULL OF MONKEY, LASIOPYGA GRISEOVIRIDIS

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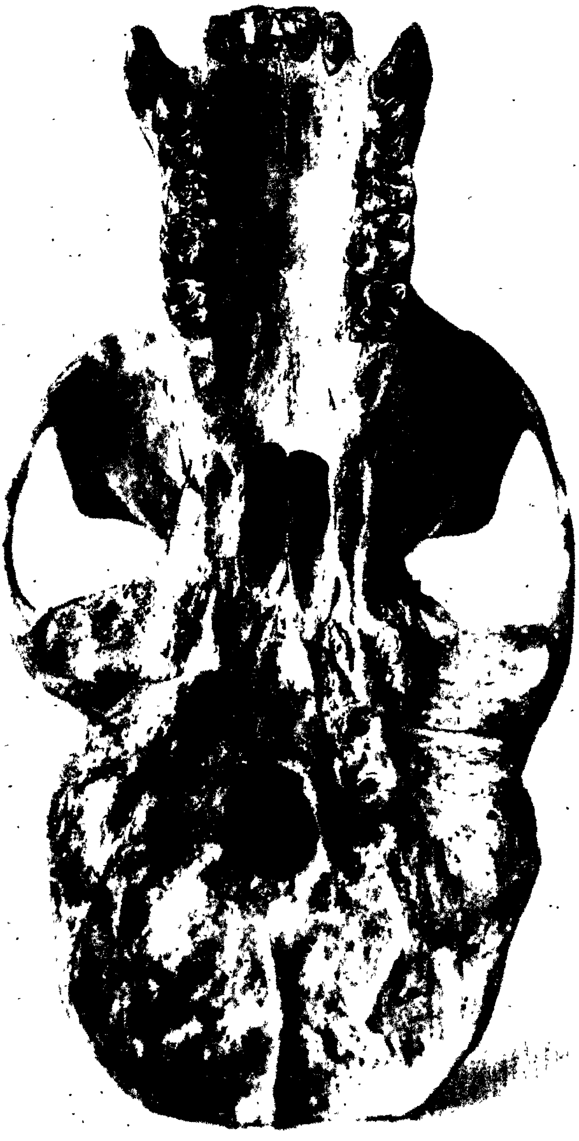

SKULL OF GORILLA

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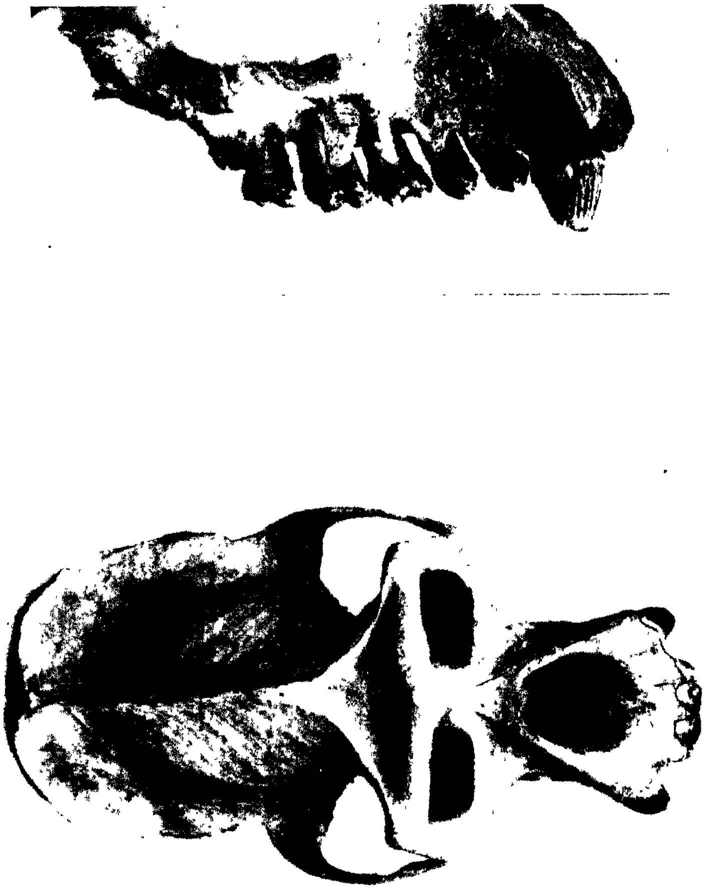

TEETH AND SKULL OF GORILLA

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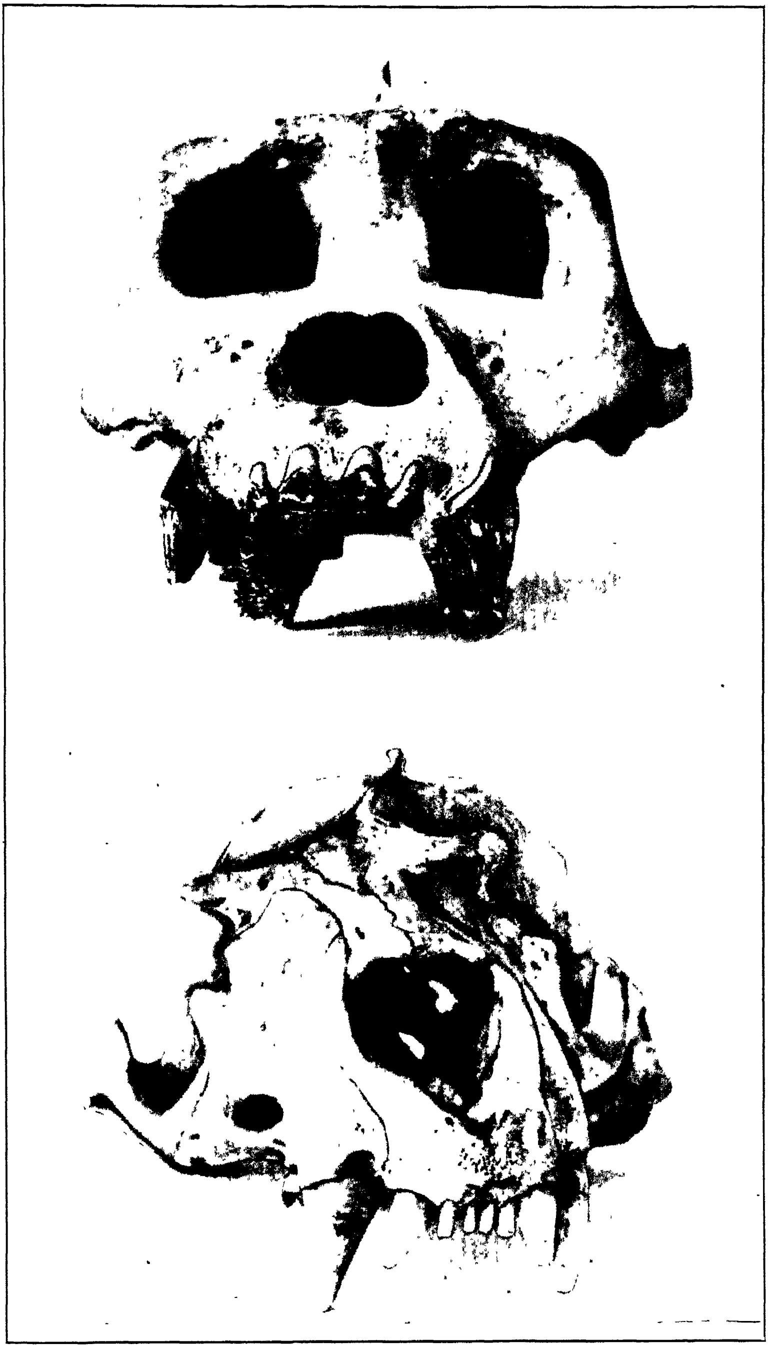
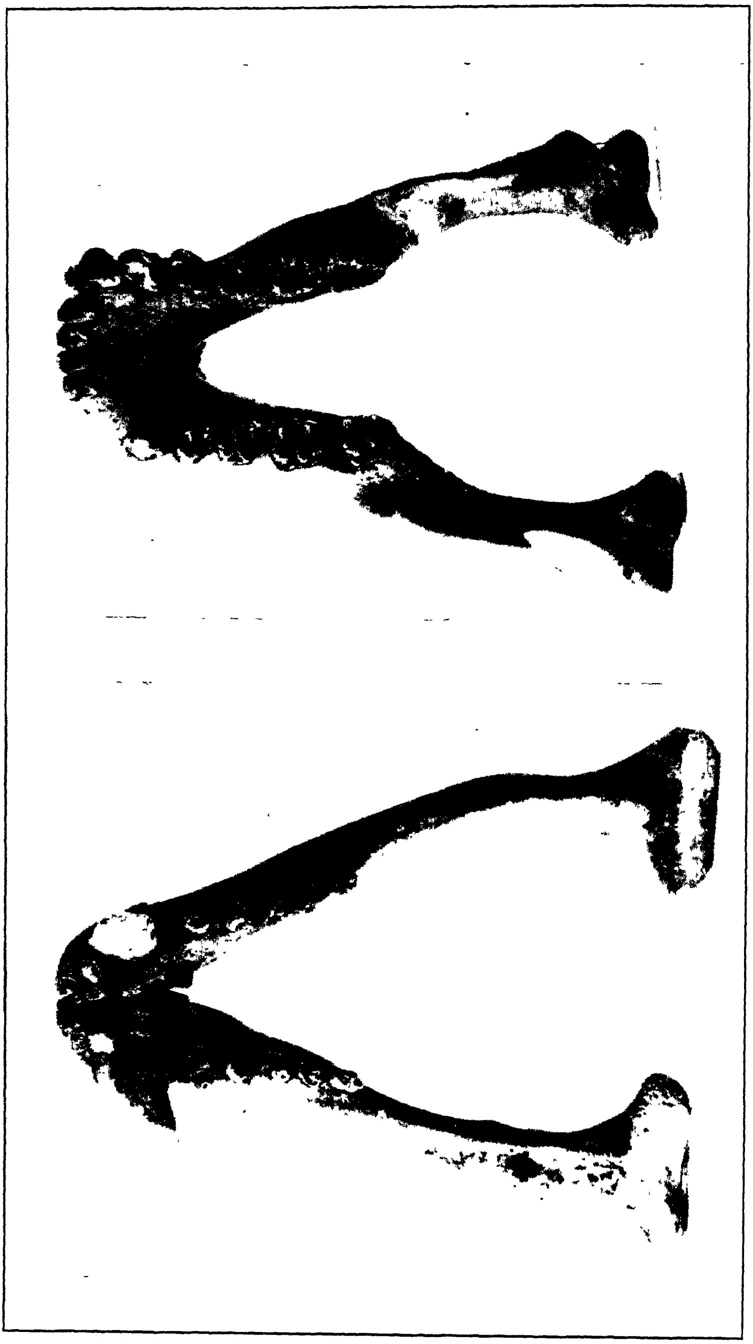


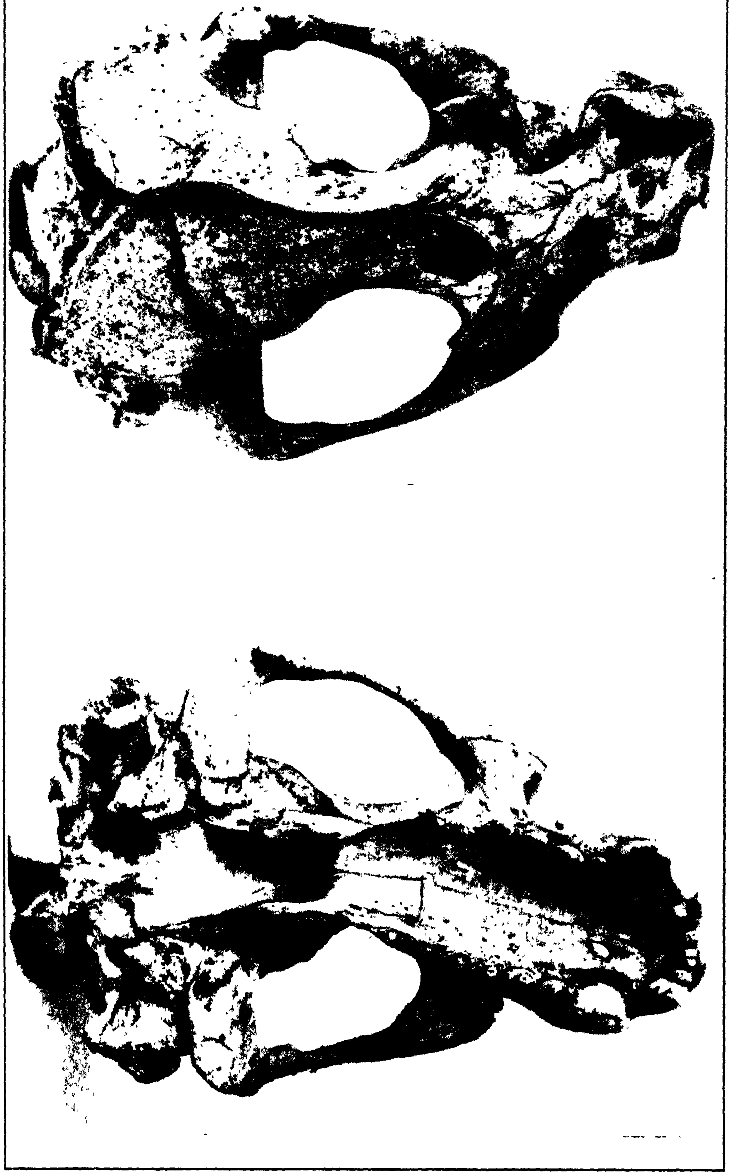
Skulls of Gorilla and Sea Lion

For explanation of plate see page 18



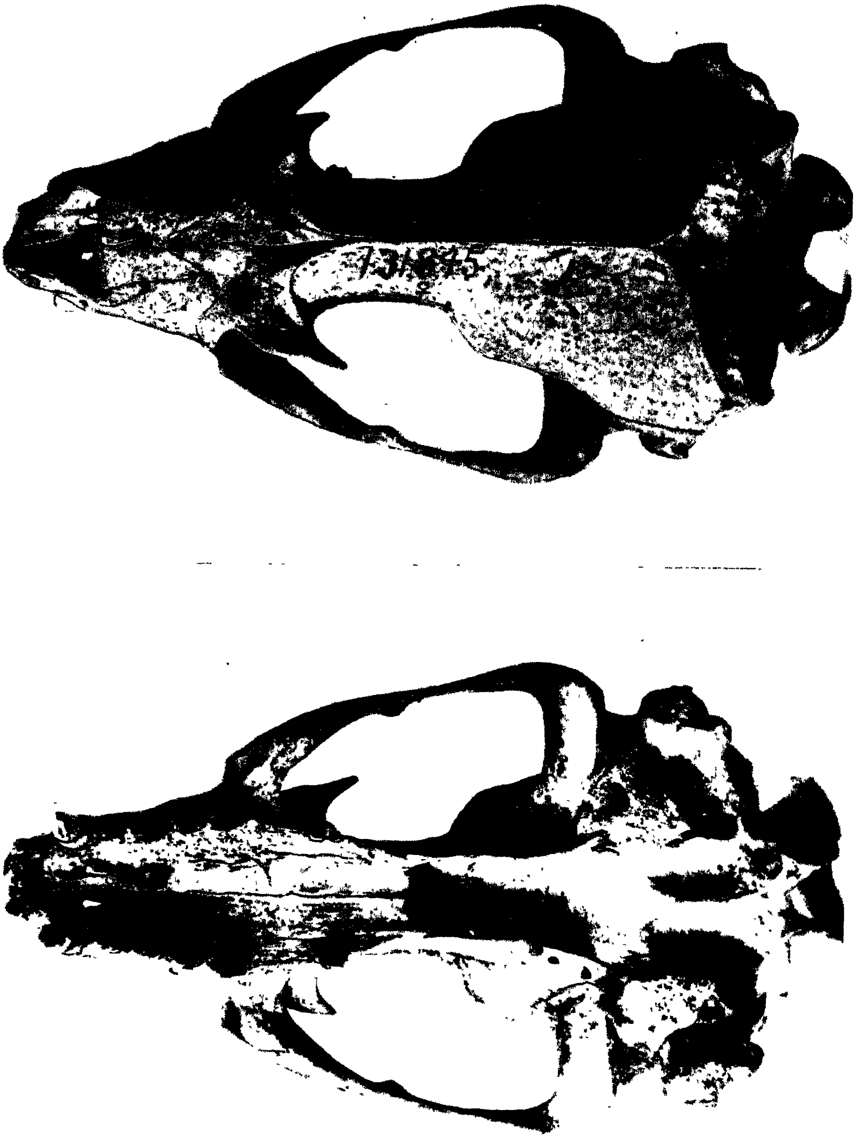
MANDIBLES OF GORILLA AND SEA LION

FOR EXPLANATION OF PLATE SEE PAGE 18



Skull of Male Sea Lion

For explanation of plate see page 18



SKULL OF FEMALE SEA LION

FOR EXPLANATION OF PLATE SEE PAGE 18

# SUPPLEMENTARY OBSERVATIONS ON THE SKULL OF THE FOSSIL PORPOISE ZARHACHIS FLAGELLATOR COPE

By Remington Kellogg

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During the past ten years a rather large number of vertebrae and other portions of skeletons of cetaceans have been obtained from the Calvert Miocene formation of Maryland. Most of these specimens were obtained by digging into the Calvert Cliffs. During severe storms many tons of sandy clay are dislodged from the face of the cliff by the undercutting action of the incoming tide. Many specimens are destroyed in this manner and at the same time others are exposed. Worn vertebrae and fragments of bones are found at frequent intervals on the beach along the Calvert Cliffs after a storm. With the exception of the zygomatic processes and the condyles, the bones of the skull do not withstand being rolled about by the waves and are soon broken up. When remains of pelagic mammals are found undisturbed in the greenish sandy clay, they are usually well preserved. Complete skeletons of these mammals are rarely found, but broken ends of bones and portions of skulls are often found protruding from the face of the cliff.

Norman H. Boss, to whom we are indebted for most of the specimens described in this and the preceding papers,[1] has been extremely fortunate in locating and collecting specimens of fossil porpoises. One of the skulls which he collected during the past year belongs to the Miocene porpoise, *Zarhachis flagellator*. Although incomplete, this skull supplies most of the structural details which were missing on the other specimen. The locality at which this skull was obtained is less than 2½ miles south of the previous discovery.

The only certainly known remains of *Zarhachis flagellator* from the Atlantic coast province of North America belong to four individuals. One of these is the type specimen, a single anterior caudal vertebra; a fairly complete skeleton which was described in 1924 represents the second specimen; the third is the cranial portion of a skull hereinafter described and figured; and of the fourth the right periotic alone was collected.

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[1] Kellogg, R., A fossil porpoise from the Calvert formation of Maryland. Proc. U. S. Nat. Mus., vol. 63, publ. 2482, pp. 1-39, pls. 1-18. March 26, 1924.

The Calvert formation of Maryland has yielded a rather large number of porpoises and in the main these species have their nearest affinities with those in the Tortonian stage of Europe. A few of them appear to have no counterparts in the European stages or at least none have been described and one of these is *Zarhachis*. Without entering into a discussion of the fauna as a whole, it is sufficient to observe in the present connection that *Zarhachis* appears to represent a highly specialized aberrant type whose family allocation is more or less a matter of personal opinion in the light of available data. If it is desirable to associate this porpoise with other genera, it must be done with the understanding that it is merely a matter of convenience. That *Zarhachis* exhibits certain characters in common with *Inia*, *Lipotes*, and *Platanista*, there can be no doubt, but whether they arose from one or three types of toothed whales can not be demonstrated from the specimens now known. According to our present knowledge, *Zarhachis* represents a type which can not be referred to any of the recognized families of toothed whales, unless the limits of these families be redefined. A natural grouping of some of the South American Miocene porpoises is not possible at present because of the lack of adequate data on the construction of their skulls. The ancestry of the *Zarhachis* type of porpoise is completely unknown at present. No fossil porpoises with this type of skull have been described from the Miocene formations of Europe. For this reason there can be little doubt but that it represents a migrant from some other region, probably the south Atlantic, which became associated with more widely distributed types during the latter part of the Miocene period.

The skull of *Zarhachis* is modified in many ways, as will be noted in the descriptive portions of this and the preceding paper. For the purpose of bringing into stronger relief the characters of this porpoise, it is necessary to compare them carefully with living river porpoises. The morphological characters involved in the construction of the skull will form the main subject of this paper.

### ZARHACHIS FLAGELLATOR Cope

*Specimen.*—Cat. No. 10911, division of vertebrate paleontology, United States National Museum. The brain case and the proximal portion of the rostrum are represented; the lachyrmals, jugals, periotics, tympanics, and bones of the inner ear are missing. Fragments of three ribs were found near this skull.

*Locality.*—The occurrence of this specimen is as follows: Near latitude 38° 38′ 45″ N., and longitude 76° 32′ W., on the western shore of Chesapeake Bay, approximately 3⅗ miles south of Chesapeake Beach, Calvert County, Md. Shown on Patuxent quadrangle or Patuxent folio. No. 152, United States Geological Survey.

*Horizon.*—The specimen was discovered and excavated by Norman H. Boss on December 30, 1923. The jagged extremity of the rostrum was found protruding from a layer of greenish sandy clay about 8 feet above the beach at a point less than 50 feet from the end of the cliff north of the Boy Scout camp. Shattuck's zones 6–8 are not clearly differentiated at this point and the specimen came from one of these three zones.

### SKULL

*Dorsal view.*—As mentioned in the preceding paper,[2] the arrangement of the bones which comprise the dorsal surface of the brain case corresponds in a general way with the skull of the Chinese porpoise, *Lipotes vexillifer*, now living in Tung Ting lake and its tributaries. There are a number of rather obvious differences, as, for instance, the development of a high crest on the extremity of each supraorbital process, the projection of the ascending processes of the premaxillae behind the nasals, the presence of a pair of crescentic orifices for nerves on the posterior walls of the "blow holes," the outward curvature of the vomerine trough to form a portion of the dorso-anterior wall of each nasal passage, and the prolongation of the anterior extremity of the zygomatic process and the postorbital projection of the supraorbital process so that they overlap. In its general features, the skull of *Zarhachis* is characterized chiefly by the exceedingly long and slender rostrum which comprises more than five-sixths of the total length of the skull, the "upended" supraorbital processes of the frontals, and the pair of crescentic orifices on the posterior walls of the nasal passages below the relatively thick nasals, peculiarities that are most noticeable when contrasted with skulls of other known porpoises. Since the rostrum was fully described in the previous paper, there is no necessity for a detailed discussion of this part of the skull.

All of the brain case posterior to the nasal passages and the "upended" supraorbital processes was missing from the first skull (Cat. No. 10485, U.S.N.M.). A small fragment of bone which appeared to be a portion of the vertex was found alongside of this skull and it was so placed in the restoration [3] of the brain case. The brain case of the second skull (pl. 1) is in a fair state of preservation and the description that follows has been prepared in the form of a supplement to the preceding paper.

Behind the antorbital notches, the maxillae push back over the frontals and expand into relatively thin horizontal plates. The outer border of each maxilla is deflected obliquely upward and inward to conform with the curvature of the "upended" crestlike portion of the supraorbital process. The maxilla sheathes the internal face of this "upended" process and its outer margin follows the crest of the latter. Behind this process, the maxilla expands horizontally and is applied to the platelike lateral extension of the frontal which in turn contributes the roof for the temporal fossa. The temporal fossae are not visible from a dorsal view and the external margin of the maxilla curves backward from the postorbital projection to the transverse crest of the supraoccipital. At the level of the nasals the whole maxilla curves strongly upward to the transverse crest of the supraoccipital. The dorsal margin of the supraoccipital and the posterior borders of the maxillae together comprise the transverse lambdoid crest. Behind the temporal fossae the lateral margins of the supraoccipital are applied to the posterior borders of the parietals and these combined bones form the thin posteriorly directed lambdoid crest which follows the curvature of the inner and lower margins of each temporal fossa.

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[2] Kellogg, R., A fossil porpoise from the Calvert formation of Maryland. Proc. U. S Nat. Mus., vol. 63, publ. 2482, pp. 1–39, pls. 1–18. March 26, 1924.

[3] Kellogg, R., Idem, pl. 1.

As in the other skull (Cat. No. 10485, U.S.N.M.) the raised convex portions of the premaxillae are widest in front of the premaxillary foramina and taper rapidly posterior to the latter, disappearing in front of the nasal passages. Both premaxillary foramina are compressed dorso-ventrally and of large size; the greatest diameter of the right foramen is 10.5 mm. The right foramen is situated 42 mm. in front of the level of the antorbital notches and the left 37 mm. From each foramen a broad groove passes forward along the internal border of the raised convex outer portion of the premaxilla. On the other skull a groove also extends backward from each foramen in an oblique direction across the premaxilla and terminates near the level of the posterior margin of the "upended" crestlike portion of the supraorbital process. On the second skull the orifice of the premaxillary foramen looks inward and forward. This change in direction of the foramen leaves the posterior margin elevated above the level of the anterior groove and shuts off the posterior groove at the source. The premaxillae are separated by an interval of 17 mm. above the porous pluglike portion of the presphenoid. The presphenoid does not rise to the level of the premaxillae, as in the first skull. Behind the level of the antorbital notches the dorsal aspect of the ascending process of each premaxilla is convexo-concave, the surface sloping from the external to the internal margin. Between the nasal passages and the antorbital notches the internal border of each premaxilla is deflected obliquely downward. The peculiarities of the premaxillae are essentially the same on both skulls. At the level of the anterior margins of the nasals the premaxillae are quite deep, and at the postero-external angle the dorsal surface is raised at least 20 mm. above the horizontally expanded plate of the maxilla. The posterior end of each premaxilla is obliquely truncated, and their posterior margins form a continuous curve with the posterior border of the protuberance behind the nasal passages. There is a relatively large dorso-ventrally compressed foramen in the maxilla at the posterior extremity of the premaxilla which opens into a short, deep groove.

In the preceding paper it was stated that "skulls of *Lipotes* and *Inia* may appear more specialized than that of *Zarhachis*[4] because of the elevation of the vertex and the shifting of the nasals to a vertical position." This opinion was based upon a small fragment of bone which appeared to represent a portion of the vertex. Further on[5] it was said that "this fragment is very important, for it shows that the vertex of the skull was not strongly elevated, or at least no prominent protuberance, like in *Inia* or *Lipotes*, was present." On reexamination it has been found that this fragment differs in a number of respects from the vertex of the second skull. The protuberance behind the nasal passages may have changed with age and varied according to sex. Nevertheless certain peculiarities of this fragment are not readily interpreted on the basis of conditions in the second skull, and there are some features which suggest the interpretation given in the preceding paper. This second skull, however, shows that other portions of the attempted restoration are incorrect and also that the protuberance behind the nasal passages is broader than in *Inia* and *Lipotes*.

The nasal bones do not overhang the nasal passages; their anteroposterior diameter is about equivalent to one-half of their breadth. The nasals are applied to the anterior surfaces of the frontals, as in *Lipotes* and *Inia*, but they are proportionately larger bones and actually increase the size of the protuberance behind the nasal passages. From a dorsal view the nasals are almost subtriangular in outline, but the posterior margin is more or less emarginate and the anterior concave. Inferiorly they are overspread by the extremities of the ectethmoids. In the case of *Inia* and *Lipotes* the nasals consist of thin plates of bone applied to the anterior surface of the protuberance behind the nasal passages, and their dorsal margins do not extend upward to the level of the dorsal surfaces of the frontals.

A narrow interparietal may be present between the crest of the supraoccipital and the protuberance behind the nasal passages. A narrow groove follows the posterior border of this protuberance and may possibly represent a suture between the combined frontals and the narrow strip of bone which, because of its position, may very well represent the interparietal. An interparietal seems to be present in the skull of *Inia geoffrensis* (Cat. No. 239667, U.SN.M.). Both condyles are visible when the skull is viewed from above.

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[4] Kellogg, R., Proc. U. S. Nat. Mus., vol. 63, 1924, p. 7.

[5] Kellogg, R., Idem, p. 13.

The exposure of the frontals on the vertex of the skull appears to be restricted to the protuberance behind the nasal passages. Posterially the frontals abut against a narrow strip of bone which has been referred to as the "interparietal" and anteriorly they are sheathed by the nasals. The protuberance separates the posterior extremities of the maxillae on the vertex of the skull. Laterally the frontals are overspread by the ascending processes of the premaxillae and by the horizontally expanded plates of the maxillae. At a lower level, a thin plate of the frontal projects laterally, forming the roof of the temporal fossa and in front of this each frontal sends out a large supraorbital process which contributes a complete osseous roof for the orbit.

The construction of the cresentic foramina below the nasal bones in the skull of *Zarhachis* (pl. 2) proved very puzzling on first examination. In order to obtain more explicit data on the relations of the bones involved, it seemed advisable to make a comparative examination of the skulls of as many genera of living toothed whales as were available for study. In the course of this review skulls were found in various stages of growth, and these have cleared up whatever uncertainties may have existed in regard to the construction of this portion of the brain case. The interpretations herewith given for the bones inclosing the nasal passages have been confirmed by direct comparison with disarticulated skulls of living dolphins.

In a skull of a young *Berardius bairdi* (Cat. No. 14218, division of mammals, U.S.N.M.) from Bering Island the presphenoid rests in the trough of the vomer and the thin lateral walls of the vomer embrace the lower half of this bone. Dorsally, there is a second platelike bone coextensive with the nasal passage which fits into a groove on the upper margin of the lateral wall of the vomer and sheathes the upper half of the presphenoid. One of these platelike bones is present in each nasal passage. These bones fulfill the requirements of the ectethmoids. Posteriorly, each ectethmoid meets the corresponding frontal edge to edge on the outer border of the frontal fontanelle. In older individuals the dorsal margins of the anteriorly directed ectethmoids meet on the mid line and fuse with a perpendicular plate of bone which extends forward from the base of the nasals to a point in front of the nasal passages, thus completely inclosing the presphenoid. The thin longitudinal perpendicular plate either represents the mesethmoid or a dorsal prolongation of the combined ectethmoids. With age, these lateral ectethmoids sheath the internal borders of the frontals and extend upward on the posterior walls of the nasal passages until they meet the anterior margins of the nasal bones from below. Minute foramina are sometimes present in these bones in some of the genera of living porpoises.

In most mammals the ethmoid plate ossifies into a median mesethmoid bone bounded below on either side by an ectethmoid. These ectethmoids develop as the cribriform plate. On each side of the perpendicular mesethmoid in skulls of the Miocene porpoises *Diochotichus*, *Ceterhinops*, and *Squalodon* there is a relatively large aperture through which the nasal branch of the ophthalmic division of the fifth cranial nerve passes. In skulls of living porpoises, like *Delphinus* and *Pseudorca*, there is a continuous sheet of bone extending upward to the base of the nasals and from which arises the mesial longitudinal perpendicular strip of bone that constitutes the most dorsal portion of the wall between the nasal passages. In each nasal passage in the skull of *Lipotes* a fissure appears to separate the longitudinal perpendicular plate or mesethmoid superiorly from the laterally placed ectethmoid. Inferiorly, the fissure extends obliquely downward across the posterior wall of each nasal passage. These fissures may represent one of the later stages in the closure of foramina similar to those in the *Zarhachis* skull. The thin longitudinal bony partition may represent either a dorsal continuation of the combined ectethmoids or the mesethmoid. Most writers in recent years have held that the pluglike porous bone, which rests in the trough of the vomer and terminates the mesorostral gutter, consists of the presphenoid below and the mesethmoid above, the bones being so intimately fused with each other that their limits can not be defined with any degree of accuracy. Such an interpretation of the mesorostral plug would place the mesethmoid below the cribiform plate in most porpoises and in others a portion would actually lie behind it. The flat platelike bone which sheathes the anterior surface of the internal borders of the frontals, conceals the frontal fontanelle, and extends upward to meet the anterior margins of the nasals from below, unquestionably represents the combined ectethmoids in the living porpoises or the cribiform plate of other mammals. The telescoping of the rostral and facial portions of the skull was accompanied by a forward thrust of the presphenoid and a backward thrust of the trough of the vomer, and as a result of one or the other, or possibly both, of the above movements, the lower portions of the ectethmoids were separated on the mid line and overspread the presphenoid laterally. Other bones may be included in these lateral plates and, in the case of *Ziphius cavirostris* Kernan[6] refers to them as including the sphenoidal turbinals.

A skull of a young *Grampus griseus* (Cat. No. 15, 773, division of mammals, U.S.N.M.) from Cape Cod, Mass., shows how the *Zarhachis* type of orifice may have developed. On this young

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[6] Kernan, John D., The skull of *Ziphius cavirostris*. Bull. Amer. Mus. Nat. Hist., vol. 38, art. 11, p. 390. August 1, 1918.

*Grampus* skull, the dorsal margins of the lateral platelike bones or ectethmoids do not meet above the presphenoid as in an older individual and above the level of the latter there is a fissure which extends inward from the internal margin of each ectethmoid to the rudimentary foramen for the nerve. In addition to this fissure, there is a shallow groove leading upward from the foramen and passing obliquely across the upper extremity of the ectethmoid. The ectethmoid has enveloped the foramen. In other mammals, the nasal branch of the ophthalmic division of the fifth cranial nerve passes outward on each side of the mesethmoid between the latter and the ectethmoid.

A critical examination of the *Zarhachis* skull (pl. 2) shows that the ectethmoid in the region of the crescentic foramen is more noticeably modified than is the case in the skull of the young *Grampus*. As in the latter, a fissure extends inward from the internal margin of the ectethmoid to the foramen, but the whole bone is more or less involuted. Each ectethmoid in the region of these crescentic orifices is twisted almost at right angles to the main body of the bone. The curvature of the ectethmoid around the foramen is so unusual in appearance that one might view the semiovoidal rostral border or the margin which is visible on plate 2 as being actually the outer margin of the ectethmoid, and the that border which surrounds the foramen at the bottom or at the caudal end of the deep crescentic aperture is the internal margin. If this is the true explanation, then the flattened condition of the ectethmoid in living porpoises is a later development and is indicative of one of the methods by which the closure of the foramen has been effected, with the accompanying loss of the sense of smell. It should also be noted that the thin perpendicular plate extending from the nasals to a point in front of the nasal passages has been destroyed.

The dorsal border of the anterior wall of each nasal passage is very thin and projects dorsally for 15 mm. or more above the porous pluglike portion of the presphenoid. Although a number of genera of toothed whales were studied, no skulls were found in which the construction of the nasal passages corresponded to the *Zarhachis* type of architecture. In *Phocaena* (Cat. No. 3659), *Tursiops* (Cat. No. 22299), and *Lipotes* (Cat. No. 218293), the dorsal margin of the anterior wall of each nasal passage is formed by a portion of the internal border of the maxilla. In all the toothed whales examined, the maxilla contributes part of the anterior wall of the nasal passage and, with the exception of *Inia* and *Stenodelphis*, it always constitutes the upper border of the anterior wall. In *Inia* and *Stenodelphis*, however, the premaxillae are thickened dorso-ventrally and closely approximated at the base of the mesorostral gutter; they constitute the upper border of the nasal passages. In *Zarhachis*, however, at least half of the upper border of the anterior wall of each nasal passage is contributed by the vomer whose upper margin rolls over or is folded outward so that it meets the maxilla slightly external to the mid line of the nasal passage. The peculiar curvature of the lateral walls of the trough of the vomer around the upper borders of the nasal passages does not appear to be duplicated in any of the living toothed whales. The maxilla contributes the outer wall and about one-half of the dorsal border of the anterior wall. Inferiorly, the palatine extends upward in each nasal passage for a distance equivalent to about three-fourths of the depth of the anterior wall and is inserted between the maxilla and vomer in the shape of a subtriangular wedge. The dorsal margin of the surface of the palatine which takes part in the formation of the nasal passage is emarginate.

In front of the nasal passages, the trough of the vomer assumes the shape characteristic of most dolphins. At the level of the anterior margin of the nasal passages, the greatest depth of the trough of the vomer is 98 mm., but at a point 180 mm. in front of these passages, it does not measure more than 25 mm. in depth. For a distance of 75 mm. in front of the nasal passages, the dorsal margins of the lateral walls of the vomer slope forward and downward at a very steep angle. This may be associated with the mesial depression of the internal borders of the premaxillae behind and in front of the premaxillary foramina. Anterior to this depression, the reduction of the lateral walls of the vomer is rather gradual. From a ventral view, the vomer is seen to be split along the mid line of the axial ridge, but this may be abnormal. The axial ridge is wedged in between the opposing faces of the maxillae and in correlation with this compression and with the slope of the internal surface of the maxilla, the floor of the mesorostral gutter is rather narrow posteriorly and it becomes so narrow about 140 mm. in front of the nasal passages that it would appear V-shaped in cross section. The lateral border of the trough of the vomer rolls over and is overspread by the thin margin of the horizontal plate of the premaxilla, which overhangs the mesorostral gutter.

*Posterior view.*—The back of the brain case (pl. 3) has been crushed in a dorso-ventral direction and the extent of this crushing is best illustrated on the posterior face of the skull. The lower half of the supraoccipital was too thin to support the great weight of the sediments which overlay the skull, and the bone fractured in many directions. A portion of the supraoccipital was thrust downward into the foramen magnum and it also buckled inward above the condyles. The displacement or amount of crushing at the center of the foramen magnum may equal 20 or 25 mm. Another consequence of this crushing is shown by the buckling of the parietals and frontals in the temporal fossae.

The posterior face of the *Zarhachis* skull resembles *Lipotes* more closely than *Inia*. The supraoccipital is wider than high, bounded on the sides and at the top by a flaring lambdoid crest. In *Lipotes*, the supraoccipital is traversed by a distinct median ridge, extending from the lambdoid crest almost to the foramen magnum. A low median crest is present on the upper half of the supraoccipital in *Zarhachis*.

The unusual depth of the thin lambdoid crest is the characteristic peculiarity of the back of the skull. On the inner and lower sides of the temporal fossa the crest curves ventrally and laterally, following the contour of the posterior border of the fossa. At the level of the lower border of the temporal fossa, the crest on the right side is fully 32 mm. deep. The thin lambdoid crest overhangs the exoccipital on each side. The exoccipitals project downward and backward, and are of a different shape than those of *Lipotes* and *Inia*, the most noticeable modification in the latter genera being associated with the development of a paroccipital process. In these living river dolphins, the exoccipital is distinctly constricted above the paroccipital process. This process projects outward and backward. In *Zarhachis*, the exoccipitals are larger, although they are not produced outward far enough to conceal the zygomatic processes from behind. The more detailed features of the exoccipitals are shown on the photograph reproduced on Plate 3. Laterally and anteriorly, the exoccipital is in contact with the squamosal, superiorly it is coalesced with the supraoccipital, while below and internally it fuses with the basioccipital. The deep jugular incisure may mark the junction of the exoccipital with the falcate process of the basioccipital.

The foramen magnum originally was probably slightly wider than high. The condyles are semielliptical in outline. They are strongly convex from side to side and are borne on distinct necks. The internal borders of the condyles are sharp edged and concave; the external borders are rounded off.

*Lateral view.*—Aside from the relatively large size of the "upended" extremity of the supraorbital process and the massive zygomatic process, the skull (pl. 4) is characterized by a short temporal fossa and a protuberance on the vertex. The protuberance behind the nasal passages is the highest point on the dorsal profile. The transverse crest of the supraoccipital is the next highest point and from this crest the maxilla slopes forward to the base of the rostrum.

Above the orbit the extremity of the supraorbital process bends abruptly upward and forms a broad crest. Portions of the outer margin of the maxilla are visible on the upper margin of this crest from a side view and it also sheathes the entire internal surface. The greatest vertical depth of the right supraorbital process is 64 mm. and the greatest anteroposterior diameter is 96 mm. The external face of the extremity of the supraorbital process is more or less flattened and slopes obliquely upward and inward. There is no distinct preorbital apophysis, but the postorbital projection is rather long and attenuate. The orbit is relatively longer than in *Lipotes*. The lachrymal and jugal are missing.

As on the first skull, the zygomatic process of the squamosal is greatly thickened dorso-ventrally in contrast to the long attenuate process of *Inia* and *Lipotes*. As viewed from the side, the slope of the posterior half of the dorsal profile of the zygomatic process is very steep; the inferior profile is biconcave. The anterior extremity is bluntly pointed; the postglenoid process is relatively thin and curves forward. The greatest length of the right zygomatic process along the glenoid face is 98 mm. and the greatest depth near the middle is 57.5 mm.

Attention has already been called to the distortion which has resulted from crushing. In addition to the previously mentioned details, it may be noted that the lateral platelike extension of the frontal and the superimposed maxilla have been depressed below their original level. A thin layer of matrix lies between the upper surface of the anterior half of the zygomatic process and the bones mentioned above.

The temporal fossa is relatively short and produced backward beyond the level of the main body of the supraoccipital. Within the fossa the parietals and frontals have buckled as mentioned before, producing some irregularities. As in *Inia* and *Lipotes*, the parietal is more or less crescentic in shape; it curves around the squamosal on the external wall of the braincase and contributes the posterior border of the temporal fossa and the external plate of the bipartite lambdoid crest, extending downward behind the squamosal until it meets the exoccipital on the lower margin of the temporal fossa. Anteriorly and superiorly, the parietal is suturally united with the frontal and inferiorly it abuts against the alisphenoid. The lateral extremity of the exoccipital is relatively thin and is directed backward. The condyles are large, knoblike in contour, and project beyond the level of the exoccipital. Most of the lower border as well as the anterior end of the external reduplication of the pterygoid is missing, exposing the axial ridge of the vomer. The falcate process of the basioccipital does not project below the postglenoid process.

*Ventral view.*—The description of the rostrum in the preceding paper fully covered this part of the skull and it seems unnecessary to repeat some of the peculiarities in the present paper, especially as no additional structural details are shown. It will also be noted that the palatal surface of this skull (pl. 5) is not as well preserved as on the first skull. Some additional details are revealed which necessitate a modification of the interpretation given for the relations of the pterygoids on the first skull.

It was stated in the preceding paper that the outer plate of the pterygoid represented the external pterygoid and the internal plate was referred to as the internal pterygoid. This interpretation does not appear to be correct, since both plates are continuous on the right side of the second skull and overspread the inferior face of the basal portion of the alisphenoid; these combined plates and the thin isthmus which unites them form the walls of the longitudinal sinus external to the basisphenoid. In view of the above, it is apparent that the outer plate represents the external reduplication of the pterygoid. The loss of the anterior end of the thin platelike external reduplication of the pterygoid on the right side exposes the pyramidal cavity on the corresponding side of the axial ridge of the vomer for its entire length. On the left side, this thin platelike external reduplication of the pterygoid extends forward 128 mm. in advance of the posterior wall of the nasal passage and contributes the external wall of the pyramidal cavity on the left side of the vomer. Posteriorly, the external reduplication of the left pterygoid extends backward beyond the nasal passages and is bounded by the maxilla anteriorly, by the frontal and alisphenoid superiorly, and by the squamosal posteriorly. The mandibular branch of the trigeminal nerve passes outward through the foramen ovale in the suture between the squamosal and the external reduplication of the pterygoid and follows the trowellike gutter on the external face of the latter. This foramen is situated in approximately the same position as in *Platanista.* There is a remarkable resemblance between the size and relations of these pterygoids and the corresponding bones in *Platanista.* The internal plates of the pterygoids are not as well preserved on this specimen as on the first skull. On the latter the thin internal plate of the pterygoid curves around the lower border of the lateral and anterior walls of the corresponding nasal passage and meets the vomer mesially; it then turns almost at right angles to the latter and is closely appressed to the external surface of the trough of the vomer. On skulls of *Inia, Lipotes,* and *Platanista* thin plates of the maxillae have overspread the external surface of the trough of the vomer and conceal all but the axial ridge of the latter. On the *Zarhachis* skull the external surface of the trough of the vomer is not overspread by the maxillae below the level of the palatines. Further comparison with the first skull is scarcely necessary, as it is now apparent that the thin anteriorly directed internal plate of the pterygoid did not by itself form the internal and superior walls of the pyramidal cavity or at least a cavity was not formed which was bounded solely by the internal plate of the pterygoid and its external reduplication as in *Platanista.*

The palatines are not visible from a ventral view when the pterygoids are complete. The sutures defining the limits of the right palatine are clearly outlined. It is a relatively narrow bone mortised into the maxilla above and bounded externally by the upper margin of the external reduplication of the pterygoid. As now understood, each pyramidal cavity is inclosed on the rear by the internal plate of the pterygoid, on the outside by the external reduplication of the pterygoid, on the inside by a thin internal plate of the pterygoid posteriorly and by the vomer anteriorly, and above by the palatine posteriorly and the maxilla anteriorly. The thin internal plate of the pterygoid does not project as far forward as in *Platanista*, but otherwise the relations between the palatines and pterygoids are essentially the same in both genera. The external reduplication of the pterygoid is not developed on skulls of *Inia* and *Lipotes*, thus exposing the entire alisphenoid. On the *Zarhachis* skull the extremity of the alisphenoid is not overspread by the external reduplication of the pterygoid and it appears within the temporal fossa in the same relative position as in *Inia*. In *Platanista* the extremity of the alisphenoid is overspread by the external reduplication of the pterygoid.

The keel of the trough of the vomer is exposed between the nasal passages and the anterior extremity of the external reduplication of the pterygoid. In its shape and relations with the surrounding bones, the vomer does not differ from that on the first skull. It expands horizontally posterior to the nasal passages, but terminates near the anterior margin of the basisphenoid.

The median region of the basicranium is rather broad, bounded on each side, as mentioned above, by a continuous wall formed by the vaginal plate of the pterygoid and the adjoining falcate process of the basioccipital. The surface of the median area between these sloping walls is more or less concave. The basioccipital is a much larger bone than the basisphenoid; the transverse suture between these bones is unusually distinct. The occipital condyles are large and are separated mesially by a deep groove. A deep jugular incisure appears between the internal margin of the exoccipital and the posterior margin of the falcate process of the basioccipital. A small condylar foramen is present on each side between the base of the falcate process of the basioccipital and the condyle.

The body of the squamosal contributes a part of the lateral wall of the brain case and its lateral projection or zygomatic process serves as the articular surface for the condyle of the lower jaw. The glenoid articular surface on the zygomatic process curves upward and forward and is concave from side to side. The external border of the zygomatic process is prolonged downward, forming a thin crest; the internal border is rounded off. The postglenoid process is short and curves forward. A shallow groove for the external auditory meatus traverses the squamosal behind the postglenoid process. A narrow posteriorly directed process of the squamosal is suturally united with the exoccipital along its external border. To the inside of the postglenoid process and at the origin of the groove for the external auditory meatus, the periotic was attached to the skull. A thin plate-like process of the squamosal which is directed inward and downward contributes the external wall of the tympano-periotic fossa; the internal wall is formed by the falcate process of the basioccipital. Between the glenoid process and the internal margin of the glenoid fossa there is a sharply defined longitudinal depression, which curves forward from the base of the groove for the external auditory meatus to the anterior margin of the squamosal. The contour of the ventral surface of the paroccipital process resembles that of *Inia* and *Platanista*. There are some minor modifications which are not developed on the paroccipital processes in the last-mentioned genera and [illegible] these the thin crest on the anterior border is the most conspicuous.

Further comparisons with skulls of the living Iniidae and with *Platanista* show some interesting structural modifications in the region of the orbitosphenoid. In *Inia*, the sphenoidal fissure is relatively large, bell-shaped in contour, and bounded laterally and on the rear by the basisphenoid, and anteriorly by the orbitosphenoid. On their outward course, the trochlearis and the ophthalmic division of the trigeminal nerve follow the groove on the ventral surface of an attenuate process of the orbitosphenoid. This groove is rather deep, with well-marked lateral walls; the process as a whole is directed obliquely outward and forward, terminating near the base of the broad channel on the supraorbital process of the frontal. The most remarkable peculiarity of the orbitosphenoid of *Inia* is the position of the ectal orifice of the optic canal. This orifice appears on the inner wall and about halfway between the anterior and posterior ends of the groove leading forward from the sphenoidal fissure. From this point forward all three nerves occupy the same groove. Within the cranial cavity, the orifice of each optic canal is placed near the inner angle of the sphenoidal fissure and is overhung by a thin platelike process of the orbitosphenoid. The course of the optic canal through the orbitosphenoid parallels the groove leading forward from the sphenoidal fissure. The apex of the process of the orbitosphenoid which contributes the surface of the groove for these nerves is jagged, and projects outward and forward at a lower level than the ventral surface of the supraorbital process.

In *Lipotes*, the sphenoidal fissure is narrower, bounded on the rear and on the outside by the alisphenoid, and on the inside and in front by the orbitosphenoid. The orbitosphenoid of *Lipotes* has the same general shape as that of *Inia* and is likewise characterized by a narrow attenuate process which is grooved for the passage of nerves. The course of the optic nerve is slightly modified in comparison with *Inia*. This nerve does not pierce the orbitosphenoid, but follows the groove on the ventral face of the attenuate process of the orbitosphenoid in company with the trochlearis and the ophthalmic division of the trigeminal. This groove is much wider than in *Inia,* and that portion of the orbitosphenoid which separated the optic canal from the above-mentioned groove has disappeared on the skull of *Lipotes.*

The observations of Anderson on the peculiarities of the orbitosphenoid in the skull of *Platanista* have been found to agree with specimens in the United States National Museum. This description [7] can be consulted for a more detailed discussion. In *Platanista,* the sphenoidal fissure is almost closed and the orbitosphenoid is pierced by an extremely small foramen for the optic nerve. The orbitosphenoid has been depressed and thrust backward so that its posterior border slides backward above the anterior margin of the alisphenoid. The ventral surface of the orbitosphenoid is broadly and deeply grooved for the trochlearis and the ophthalmic division of the trigeminal nerve which pass out through the sphenoidal fissure and continue forward along this canallike continuation of the fissure. As viewed through the foramen magnum the cranial orifice of each optic canal is overhung by a thin platelike process of the orbitosphenoid. The minute ectal orifice of the orbitosphenoid portion of the optic canal appears on the inner wall of the canallike continuation of the sphenoidal fissure near the level of the anterior border of the alisphenoid. The upper border of the external reduplication of the pterygoid and a thin platelike process of the frontal which slides forward under the maxilla, as viewed from in front, enclose the passage for the optic nerve from below as it curves forward and outward; the ectal orifice of the optic canal appears near the internal extremity of the lachrymal. The optic canal, as it passes outward along the supraorbital process, is bounded on three sides by the thin plates of the frontal and roofed over by the maxilla. This thin platelike anteriorly directed process of the frontal also conceals the basal half of the supraorbital process from a ventral view. The canallike continuation of the sphenoidal fissure for the passage of nerves is concealed by the pterygoid. Imperfections in the ossification of the walls of the optic canal occur in most skulls of *Platanista.*

In *Zarhachis,* the course of the optic nerve from the point where it issues from the cranial cavity to the base of the supraorbital process is concealed by the external reduplication of the pterygoid. The edges of the bones surrounding the ectal orifice of the optic canal are broken and jagged on the second skull and no attempt has been made to remove the matrix from this region on the first skull because of its fragile condition. Hence one can not be certain what modifications were present around the ectal orifice of the optic nerve near the base of the supraorbital process of the frontal. Both frontals appear to have developed thin plates. It is possible that they may have curved below the optic nerve in the same manner as in *Platanista.* This point can not be settled on the basis of these two skulls alone.

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[7] Anderson, J., Anatomical and Zoological Researches: Comprising an account of the Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875. London (1878), pp. 511–512. 1879.

In the preceding paper[8] attention was called to the presence of a peculiar shelf in the temporal fossa above the upper margin of the squamosal. It is now apparent that this shelf was the result of crushing and the consequent buckling of the bones involved and that it is not comparable with a similar groove on the skull of *Platanista.* The second skull has suffered in the same way on the right side, but to a lesser degree.

At the base of the falcate process of the basioccipital and near the posterior margin of the alisphenoid is the partially closed ectal orifice of the canal for the carotid artery. The mandibular branch of the fifth cranial nerve issues through a cleft on the posterior border of the alsiphenoid at a point 11 mm. external to the orifice of the carotid canal and on its forward and outward course crosses the ventral face of this bone, finally emerging in the temporal fossa through the foramen ovale.

A postero-external process of the alisphenoid projects backward, meeting the squamosal along its external border, abutting against the exoccipital posteriorly, and uniting with the underlying process of the basioccipital internally. The alisphenoid and the above mentioned bones form the fossa in which periotic and tympanic bones are lodged. A small foramen pierces the alisphenoid above the anterior process of the periotic. Two large foramina appear in this fossa above and internal to the jugular incisure. The ectal orifice of the internal foramen is situated internal to the jugular incisure; it opens at the base and near the posterior margin of the falcate process of the basioccipital. This foramen probably represents the compartment for the nerves in the *foramen lacerum posterius.* The external foramen is partially inclosed by the exoccipital and may afford a passage for the jugular vein. The foramina within the tympano-periotic fossa have the same general arrangement as on one skull of *Eurhinodelphis bossi*[9] which was also obtained from the Calvert formation. In skulls of *Platanista, Inia,* and *Lipotes,* a large fissure occupied the area corresponding to the tympano-periotic fossa on the *Zarhachis* skull.

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[8] Kellogg, R., Proc. U. S. Nat. Mus., vol. 63, pp. 18–19. 1924.

[9] R. Kellogg, On the occurrence of remains of fossil porpoises of the genus Eurhinodelphis in North America. Proc. U. S. Nat. Mus., vol. 66, publ. 2563, pl. 5. 1925.

MEASUREMENTS FOR THE SKULL (in millimeters)

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|---|---|
| Breadth of rostrum at base (between antorbital notches) | 163 |
| Greatest breadth of skull across supraorbital processes | 260 |
| Greatest breadth of skull across zygomatic processes of squamosals | 260 |
| Vertical height of skull (between tips of falcate processes of basioccipital and frontals on vertex of skull) | 165.5 |
| Vertical height of skull (basisphenoid to frontals on vertex of skull | 128 |
| Greatest depth of rostrum at level of antorbital notches | 89 |
| Greatest distance between outside margins of premaxillae at level of anterior margin of porous pluglike presphenoid | 93 |
| Greatest distance between outside margins of premaxillae at level of anterior margin of nasals | 130 |
| Greatest breadth of right premaxilla in front of nasal passages | 44 |
| Length of frontal plate of right maxilla (antorbital notch to supraoccipital) | 141.5 |
| Greatest breadth of exposed surface of frontal plate of right maxilla behind supraorbital process | 66 |
| Least distance across vertex of skull between inner margins of maxillae | 39 |
| Greatest antero-posterior diameter of supraorbital process of right frontal | 96 |
| Greatest dorso-ventral depth of supraorbital process of right frontal | 63.5 |
| Greatest thickness of "upended" portion of supraorbital process of right frontal | 40 |
| Least breadth of braincase between temporal fossae | 120 |
| Least distance between temporal fossae as measured between lambdoid crests | 141.5 |
| Distance from center of transverse crest of supraoccipital to upper margin of foramen magnum | 104.5 |
| Greatest breadth of supraoccipital | 151 |
| Breadth of foramen magnum | 42.5 |
| Greatest distance between outside margins of occipital condyles | 105 |
| Greatest dorso-ventral diameter of right condyle | 53 |
| Greatest transverse diameter of right condyle | 42 |
| Greatest distance across skull between outside margins of exoccipitals | 212 |
| Depth of left exoccipital at extremity | 72.5 |
| Distance from anterior margin of foramen magnum to right nasal passage | 122 |
| Distance from horizontal plate of right maxilla to extremity of right paroccipital process | 127+ |
| Greatest antero-posterior diameter of zygomatic process of right squamosal | 101 |
| Distance between anterior margin of apophysis of right maxilla and posterior face of right condyle | 215 |
| Greatest breadth of basioccipital across tips of the falcate processes | 101 |
| Distance between anterior margin of foramen magnum and anterior margin of basisphenoid | 86 |
| Greatest length of right nasal | 14 |
| Greatest breadth of right nasal | 26 |
| Greatest length of exposed portion of right frontal on vertex of skull | 34 |
| Greatest breadth of exposed portion of right frontal on vertex of skull | 28 |

## EXPLANATION OF PLATES

*Zarhachis flagellator* Cope. Cat. No. 10,911, division of vertebrate paleontology, United States National Museum. Calvert formation, western shore of Chesapeake Bay, about 3⅖ miles south of Chesapeake Beach, Calvert County, Md. Collected by Norman H. Boss, December 30, 1923.

### PLATE 1

Dorsal view of skull of *Zarhachis flagellator* Cope. About ⅖ natural size. The following abbreviations are used on plates 1 to 5. *Bo.*, basioccipital; *Bs.*, basisphenoid; *C.*, condyle; *Cr. l.*, lambdoid crest; *Cr. max.*, maxillary crest; *Ect.*, ectethmoid; *Ex. oc.*, exoccipital; *Ex. pt.*, external reduplication of the pterygoid; *Ex. aud. M.*, groove for external auditory meatus; *Fal. pr.*, falcate process of basioccipital; *F. m.*, foramen magnum; *Fo. c.*, condylar foramen; *Fo. inf.*, ventral orifice of infraorbital canal; *Fo. l. p.*, *foramen lacerum posterius*, compartment for vein; *Fo. max.*, maxillary foramen at posterior extremity of the premaxilla; *Fo. ov.*, foramen ovale; *Fo. pmx.*, premaxillary foramen; *Fr.*, frontal; *J. inc.*, jugular incisure; *Max.*, maxilla; *N. A.*, left nasal passage; *Na.*, nasal; *Pa.*, parietal; *Pmx.*, premaxilla; *Poc. pr.*, paroccipital process of exoccipital; *P. pr.*, postglenoid process of squamosal; *Prs.*, presphenoid; *Pt.*, vaginal process of pterygoid; *S. oc.*, supraoccipital; *S. or. pr.*, supraorbital process of frontal; *Sq.*, squamosal; *Vo.*, vomer; *Zyg.*, zygomatic process of squamosal; *1*, foramen in alisphenoid above the anterior process of the periotic; *2*, passage for mandibular branch of trigeminal nerve in a cleft on posterior border of alisphenoid; *3*, *foramen lacerum posterius*, compartment for nerves.

### PLATE 2

Frontal view of skull of *Zarhachis flagellator* Cope showing position of the crescentic foramina. About ⅗ natural size.

### PLATE 3

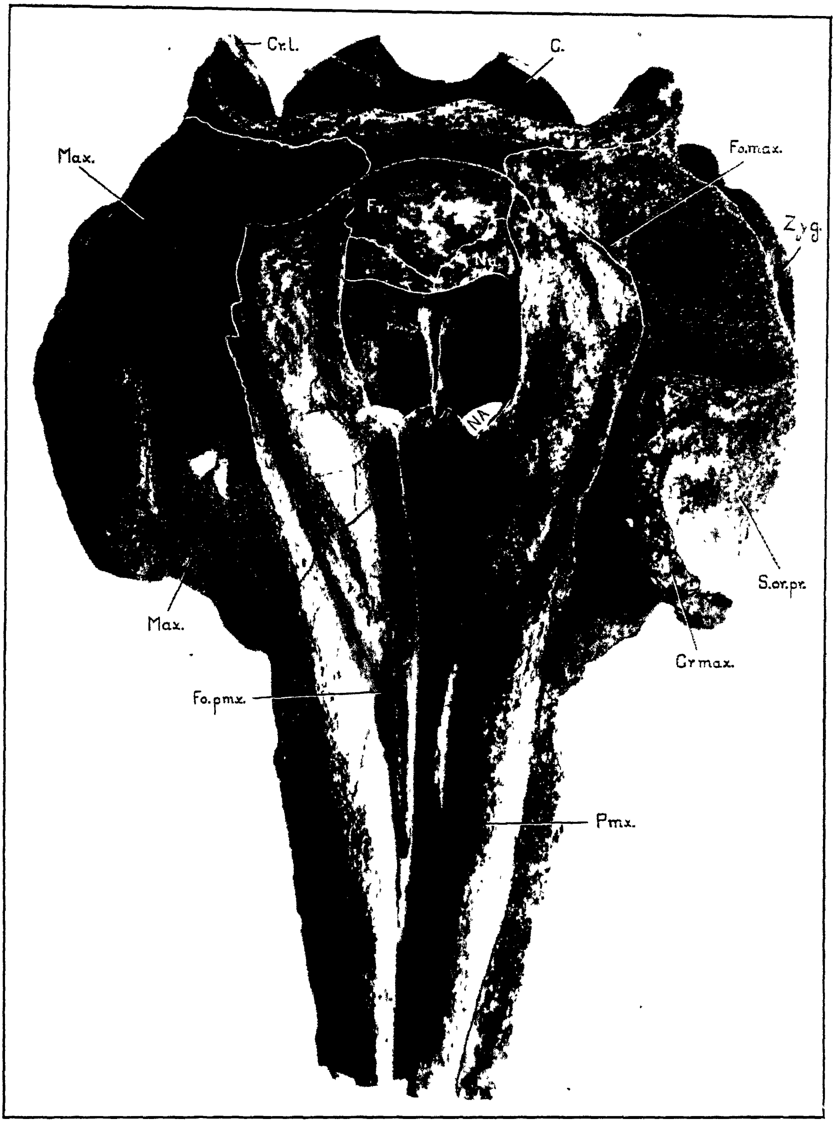
Posterior view of skull of *Zarhachis flagellator* Cope. About ⅗ natural size.

### PLATE 4

Lateral view of skull of *Zarhachis flagellator* Cope. About ½ natural size.

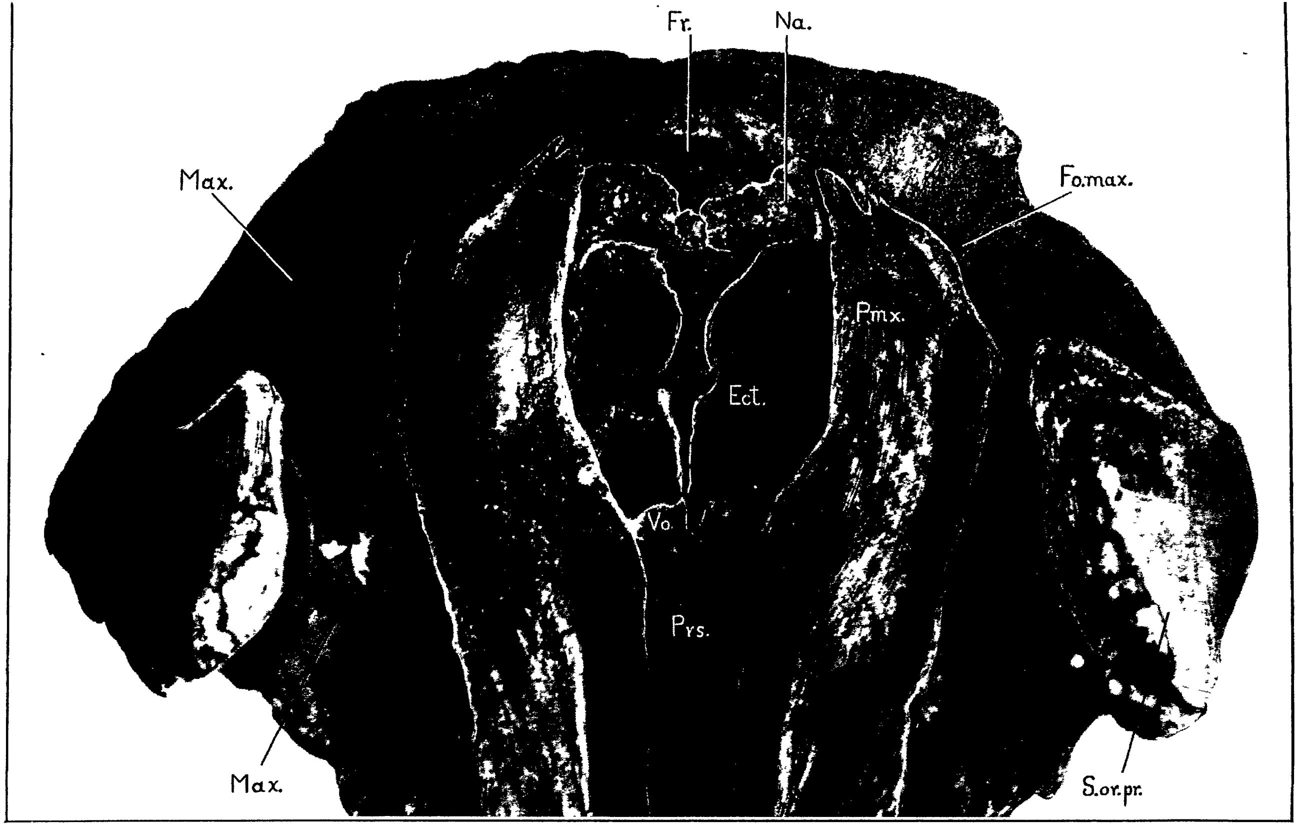
### PLATE 5

Ventral view of skull of *Zarhachis flagellator* Cope. About ⅖ natural size.



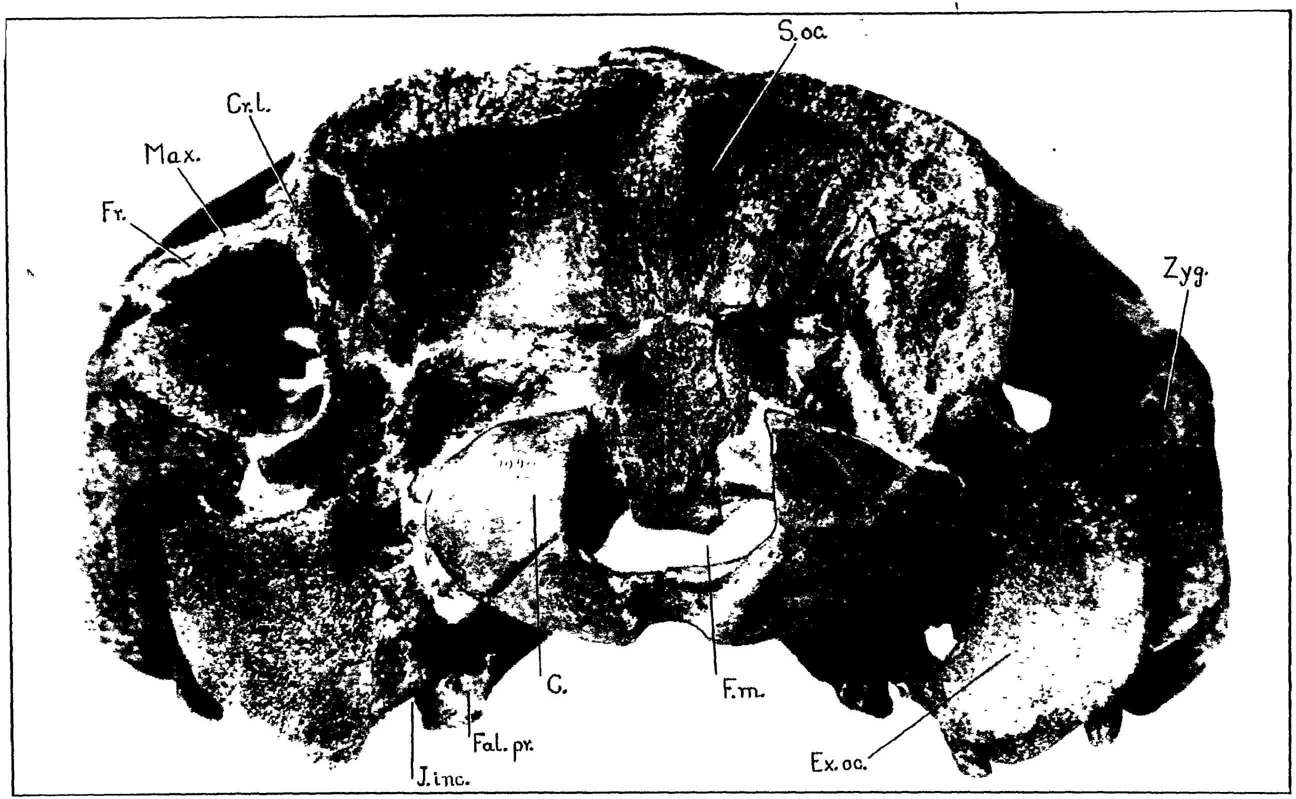
DORSAL VIEW OF SKULL OF ZARHACHIS FLAGELLATOR

FOR EXPLANATION OF PLATE SEE PAGE 18



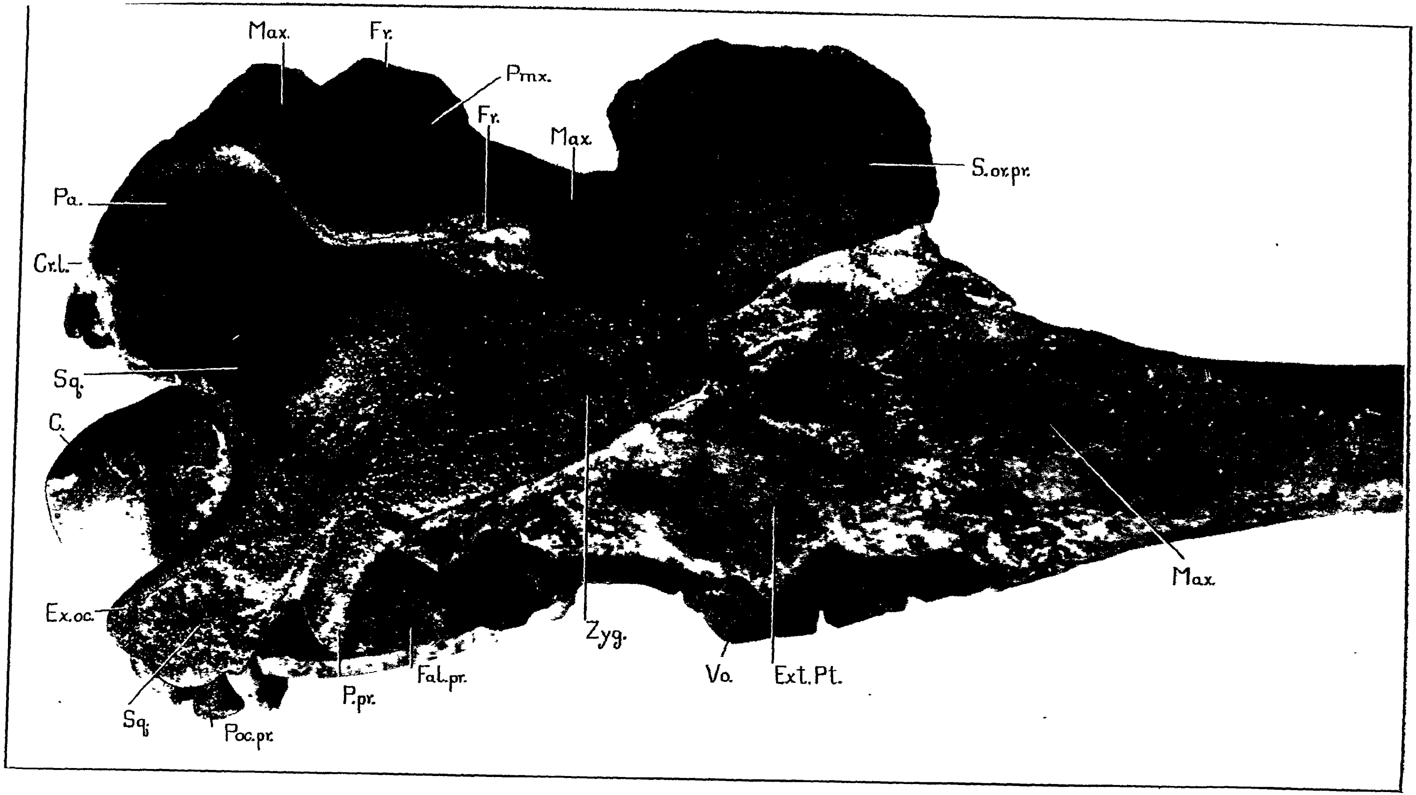
FRONTAL VIEW OF SKULL OF ZARHACHIS FLAGELLATOR

FOR EXPLANATION OF PLATE SEE PAGE 18



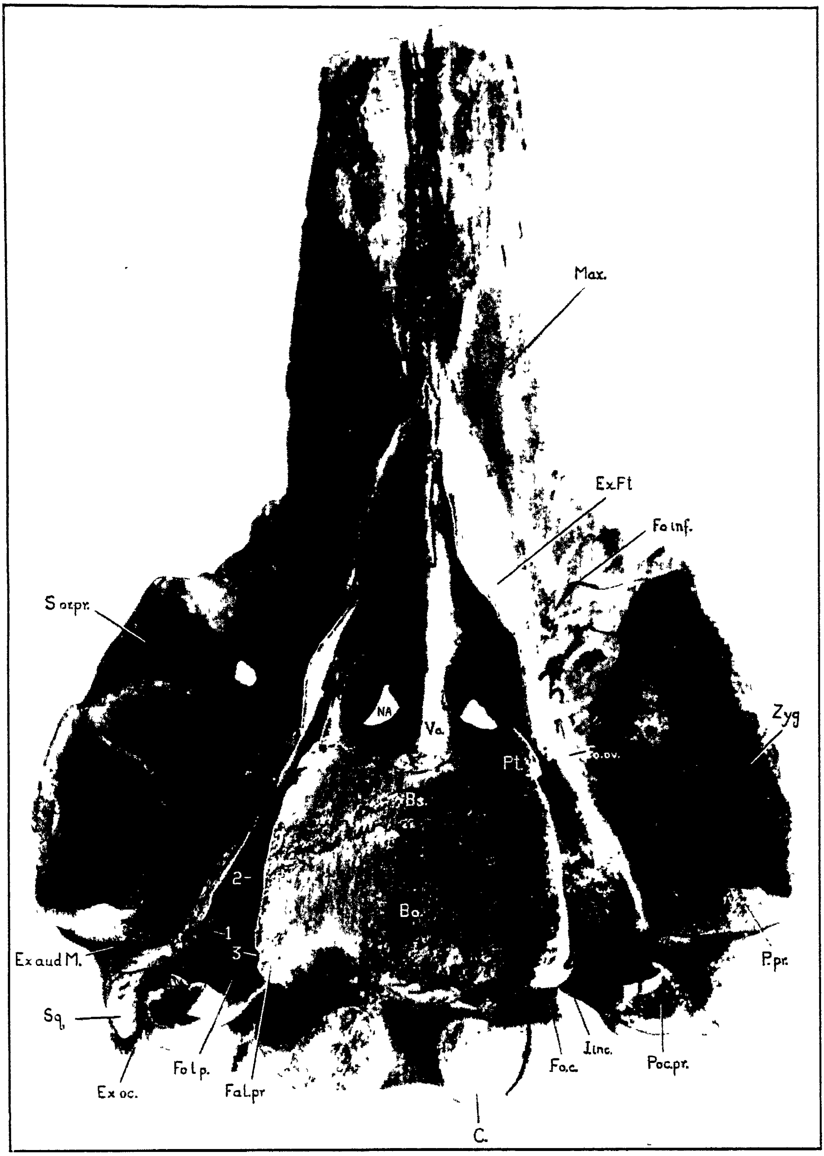
Posterior View of Skull of Zarhachis flagellator

For explanation of plate see page 18



LATERAL VIEW OF SKULL OF ZARHACHIS FLAGELLATOR

FOR EXPLANATION OF PLATE SEE PAGE 18



VENTRAL VIEW OF SKULL OF ZARHACHIS FLAGELLATOR

FOR EXPLANATION OF PLATE SEE PAGE 18

# A LIST OF THE ANNELIDS COLLECTED BY CAPTAIN R. A. BARTLETT IN ALASKA, 1924, WITH A DESCRIPTION OF A NEW SPECIES

By A. L. Treadwell

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Among a collection of annelids made by Capt. R. A. Bartlett in Alaska during the summer of 1924, under the auspices of the National Geographic Society, and submitted to me for examination by Dr. Waldo L. Schmitt of the United States National Museum, was a single specimen belonging to the genus *Enipo,* which apparently represents a new species. The specimen is entire, but has lost all of its elytra, so that I am unable to give any details of these latter organs.

The other annelids represented in the collection were *Harmothoe imbricata* Linnaeus, *Eunoe barbata* Moore, *Nereis pelagica* Linnaeus and *Nephthys,* species. The material was dredged at three different localities: About 15 miles north of Big Diomede Island, Bering Strait, June 14, 1924; south of Big Diomede Island, and in the mouth of Kotzebue Sound, July 10 and 12, 1924, 12–17 fathoms. From south of Big Diomede Island but one mutilated and hence questionably determined *Nereis pelagica* was obtained; otherwise the species were found at each of the other localities, except the new species which was taken only in Kotzebue Sound, and the fragmentary *Nephthys* from north of Big Diomede Island.

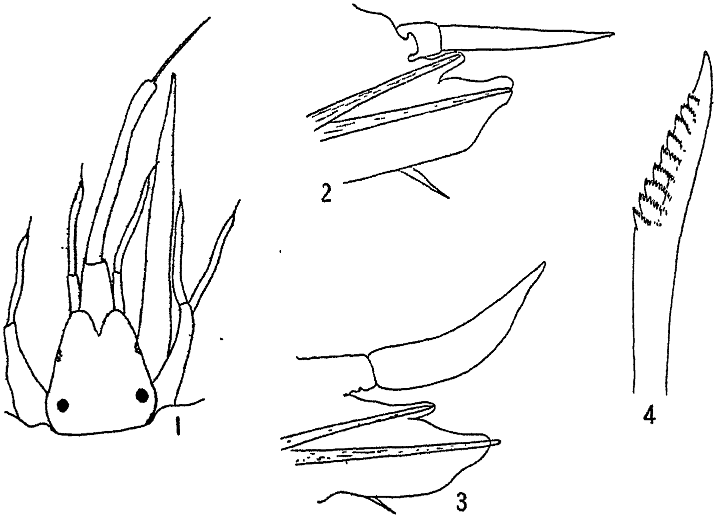
## Genus ENIPO Malmgren

### ENIPO CIRRATA, new species

The body has a length of 38 mm. with a prostomial width of 1 mm. and a greatest body width of 2 mm.; and contains 64 somites. There are 15 pairs of elytrophores on somites 2, 4, 5, 7, 9, etc., 23, 26, 29, and 32.

The length of the prostomium (fig. 1) is about equal to its greatest width, which is at the level of the posterior pair of eyes. The median cleft is not very prominent, and the apices are rounded with no trace of pointed peaks. The posterior pair of eyes are large and prominent, the anterior pair equal to these in size but because of their position on the sides of the prostomium are barely visible from above.

The cirrophore of the median tentacle is very large and about one-third to one-fourth as long as the style. The latter tapers only very gradually toward the apex, but suddenly narrows and ends in a long slender terminal filament. The cirrophore is colored a dark brown and this color is continued on to the style, becoming more intense toward the end. The extreme apex of the style and the terminal filament are colorless. The lateral tentacles resemble the median in outline, but are lighter in color and the narrowing to form the terminal filament is much less marked. They are slender and very short, hardly longer than the cirrophore of the median tentacle.



FIGS. 1-4.—ENIPO CIRRATA, 1, ANTERIOR END × 12.5; 2, 15TH PARAPODIUM × 22.5; 3, PARAPODIUM FROM SOMITE 52 × 22.5; 4, VENTRAL SETA × 250

The left palp is lost. That on the right side is colorless, not very stout and extends about as far as the median tentacle. The tentacular cirri resemble the lateral tentacles in form and color.

The body in general is faintly tinged with brown, but there is very little definite pigmentation. On the third somite are short transverse bands in the mid-dorsal line, and these are repeated in subsequent somites up to the ninth, becoming much broader in the latter somite and in somites 8 and 9 forming an indistinct patch rather than definite bands. Toward the posterior end of the body the broad dorsal cirri are decidedly brown in color.

The fifteenth parapodium (fig. 2) has a truncated neuropodial lobe into the apex of which a single acicula extends. The notopodium is represented only by a small rounded lobe and its acicula is somewhat smaller than that of the neuropodium. The dorsal cirrus has a stout cirrophore, and the style extends about one-half its length beyond the neuropodium. The ventral cirrus is short and slender. In the parapodium drawn there are six stout setae in the neuropodium and stubs of three or four in the notopodium.

A parapodium from somite 52 showed in general much the same structure as the above (fig. 3) except that the dorsal cirrus has a broad flattened style, almost as large as sometimes occurs in the *Phyllodocidae*. Some of these have small club-shaped processes visible only under high power scattered over the surfaces.

The ventral setae (fig. 4) are stout with ends entire and about 9 rows of toothed plates visible in profile as projecting teeth. I was unable to find any unbroken dorsal setae, but the few fragments that remain indicate that they have very slender shafts with numerous transverse rows of delicately toothed plates.

One anal cirrus remains. This is similar to the posterior dorsal cirri in general form but is rather more slender.

*Type.*—The unique holotype, Cat. No. 19139, U.S.N.M., was collected in the mouth of Kotzebue Sound, Alaska, July 12, 1924, 12–17 fathoms.

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